the glass industry

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The Glass Division—

at the 59th Annual ACS Meeting

Neither floods nor high-water kept over eighteen hundred glassmen and ceramists, their friends, and wives from gathering in Dallas, Texas, the week of May 5-9 for the 50th Annual Meeting of the American Ceramic Society. The meeting was held at the Statler-Hilton Hotel, a perfect setting for the various meetings.

The Glass Division provided a most interesting program, and a number of foreign visitors were present from Mexico, Canada, South America, and Finland. Among the group were Risto Tiitola, Karhula, Finland; and L. M. Aguilar, Jaime Lozano, and M. Gorza of Mexico. The program, which included a joint session with the Basic Science division, was arranged by the following committee: Frank R. Bacon, Owens-Illinois Technical Center, Toledo, Ohio, chairman; J. R. Hensler, Chemical Research Laboratory, Bausch and Lomb Optical Company, Rochester, New York; and Ralph K. Day, Libbey-Owens-Ford Glass Company, Toledo, Ohio.

The initial session on Monday afternoon was introduced by F. R. Bacon, who acted as session chairman. The first paper was "Stress Measurements in Circular Cylinders," by Paul M. Sutton, Corning Glass Works, Corning, New York.

Stress measurements were made on glass cylinders using a Friedel polarimeter and a technique previously developed by Ritland. Certain assumptions and generalizations were made to provide a procedure whereby all the internal stresses in a glass cylinder can be calculated from birefringence observations. Curves were shown illustrating the effects of variable cooling conditions. The method was applied to circulator cylinders, either rods or tubes, where the stress distribution may be any arbitrary function of the radial coordinate and where the observation path is far enough from the ends of the cylinder so that end effects are negligible. The method was applied to an oil tempered solid glass rod, and the calculated stress was compared to that expected from constant cooling rate.

The next paper, "Measurement of Stress Optical Coefficient and Rate of Stress Release in Commercial Soda-Lime Glasses," was written by A. F. Van Zee and H. M. Noritake, Owens-Illinois, and presented by Mr. Van Zee. It was pointed out that although highly important, stress-optical coefficient measurements at high temperatures have been very limited. A method was described for measuring the stress-birefringence properties of soda-lime glasses in the range of 75 to 1200° F. The results were excellently depicted by means of carefully prepared colored slides that added much to their understanding. Data on three glasses show that the stress-optical coefficient increases slowly with temperature, reaching a definite maximum in the range 1050 to 1100° F.

The same apparatus was used to measure rate of stress release in two of these glasses. Data obtained under thermal equilibrium conditions can be represented by equations of the form:

$$S_t = C_1 e^{\frac{-t}{\tau 1}} + C_2 e^{\frac{-t}{\tau 2}} - C_3$$

wherein

S_t = stress level after given soaking time.

$\tau 1$ = is a relaxation time for a rapid decaying mechanism.

$\tau 2$ = is a relaxation time for a slow decaying mechnism.

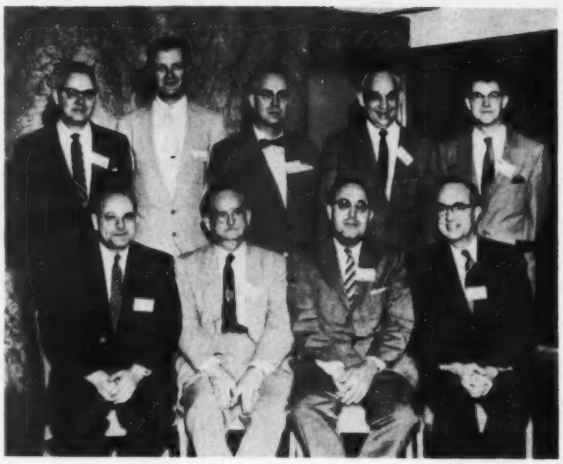
C_1, C_2, and C_3 are constants.

This formula suggests that two or more concurrent

mechanisms are involved in stress release in these glasses within the viscosity range log 12 to log 14.5; a rapid one of 0.4 to 10 minutes duration and a slow one of 2 to 60 minutes.

It was further suggested that perhaps two phases were present in glass, one of which was more mobile than the other and thus explained certain delayed elastic effects.

The next paper was, "Elastic Properties of Glasses" by Harold T. Smyth, Rutgers, The State University, New Brunswick, New Jersey. Mr. Smyth presented some theoretical work, sponsored by the Office of Naval Research, in an effort to explain elastic properties in glass. Most data indicate that Poisson's ratio in glass is approximately equal to 0.25. If all of the work performed in deforming a sample of glass went into stretching or compressing the Si-O-Si links and if each of these links obeys Hooke's Law, then it can be shown by setting up the strain-energy function that Poisson's ratio would be 0.25. If, on the other hand, all of the work went into angular deformation of the oxygen tetrahedra around each silicon, the Poisson's ratio would be −1.00. The fact that it is usually somewhat less than 0.25 indicates that most of the strain energy lies in the stretching and compressing of the Si-O-Si links.



The following 1957-58 A. C. S. Officers were installed at the 59th Annual Meeting: left to right, seated, Andrew Pereny, Pereny Equipment Co., Columbus, O., treasurer; Dean John F. McMahon, Alfred University, president; R. S. Bradley, A. P. Green Fire Brick Co., Mexico, Mo., president-elect; Karl Schwartzwalder, AC Spark Plug Division, General Motors Corp., outgoing president; standing, Eugene C. Clemens, Cannelton Sewer Pipe Co., Cannelton, Ind., trustee, Structural Clay Products Division; Frank Jansma, B. F. Drakenfeld & Co. Inc., Washington, Pa., trustee, Materials and Equipment Division; J. S. Nordyke, Hammond Lead Products, Pittsburgh, society vice-president, C. H. Hahner, National Bureau of Standards, Washington, D.C., society vice-president; and Wayne A. Deringer, A. O. Smith, Corp., Milwaukee, society vice president.

Where large modifying ions are present such as K^+ and Ba^{2+}, Poisson's ratio may be greater than 0.25 (even as high as 0.30). This may be accounted for by assuming that each of these ions fill the interstices in which they are located and tend to make the glass incompressible.

Data are being collected on special glass compositions that will broaden available knowledge on this subject.

The next paper, "The Effect of Thermal History on Glass Characteristics," was written by H. E. Hagy and H. N. Ritland, Corning Glass Works, Corning, New York, and presented by Mr. Hagy.

Thermal expansion data were presented for two glasses for both heating and cooling at constant rates. The compositions of the glasses were as follows:

	Glass A	Glass B
SiO_2	71.3 per cent	70 per cent
Na_2O	17.4	9
K_2O	....	7
BaO	9.0	3
B_2O_3	....	11
Al_2O_3	2.0	..
Annealing Pt.	470° C.	555° C.

Heating data were taken on samples with varying thermal histories, brought about by either constant-rate cooling or by constant-temperature stabilization prior to the expansion test.

It was concluded that the contraction curve of glass during cooling at a constant rate can be analyzed in terms of four regions:

1. *High Temperature.* At high temperatures, the curve is essentially linear. In this range the total expansivity is the sum of a structural term and a vibrational term extrapolated from the low temperature expansion.

2. *Transformation Range.* In this region the structural expansivity decreased exponentially, with a corresponding decrease in the slope of the curve. This art of the curve shifted upward along the temperature axis by an amount proportional to the logarithm of the cooling rate.

3. *Low Temperature.* Below the transformation range, the curve is again approximately linear with a small quadratic term. The expansion in this range is almost entirely due to lattice vibrations.

4. *Mixed Alkali Glasses.* In mixed alkali glasses, an ionic process contributes a small part of the total expansion. This effect freezes out, during cooling, in the neighborhood of 100-150°C and causes a small but observable departure from the quadratic curve below this temperature range. The magnitude of this effect can be calculated from refractive index measurements.

The expansion behavior (heating curves) of glass with varying thermal histories was demonstrated. A simple "fictive temperature" concept was shown to be inadequate to explain this behavior.

The next paper was "Dielectric Loss and the States of Glass" by D. W. Rinehart, Pittsburgh Plate Glass, Creighton, Pennsylvania. The behavior of glasses as a dielectric depends upon many factors and varies considerably with composition.

Through the use of the method of quenched samples, the effect of thermal history on the room temperature dielectric loss of plate glass was studied over a range of quenching temperatures extending from 200 to 1200°F. The shape of the typical tan δ vs quenching temperature curve indicates a redistribution of sodium ions within the structural interstices at quenching temperatures below the lower limit of the transformation range. Above this temperature, configurational changes in the silica structure become apparent. The extent of compaction accompanying annealing was clearly indi-

cated in a family of tan δ quenching temperature curves with initial state as a parameter.

The data were collected on 2 in. dia. ¼" glass plates of the following composition:

SiO_2	71.5
Na_2O	13.5
CaO	11.8
MgO	2.4
SO_3	0.5
Fe_2O_3	0.12
Al_2O_3	0.2

The next paper, "Compaction Variations in Heat-Treated Plate Glass," was also presented by Mr. Rinehart. Differences in compaction which would be expected to exist within a glass specimen quenched from some temperature within its transformation range were investigated for plate glass, of a composition indicated in the previous paper, using dielectric loss measurements as a probe. A decrease in tan δ, which normally accompanies a more compact state, was used as a criterion as the specimen thickness was gradually reduced by equal amounts from both surfaces leaving finally a thin inner core. The non-dependence of tan δ on strain was demonstrated.

The Tuesday morning session was ably guided by J. Earle Duncan, Pittsburgh Plate Glass Company, Creighton, Pennsylvania, who acted as chairman.

The first paper was "Some Notes on the History of Tempered Glass," by Alexander Silverman, University of Pittsburgh, Pittsburgh, Pennsylvania.

This paper was given by title only because Mr. Silverman was unable to attend owing to illness. Attempts were made to present a history of the art of tempering glass. Contributions of individuals from the United States and aboard were solicited, and it is hoped to have a complete history and development of this very important contribution to glass technology. Although the art is old, the techniques vary considerably and a complete compilation of the history of this art is to be desired.

Mr. Harrison Davies, Mellon Institute, Pittsburgh, Pennsylvania, who is chairman of the Third Gordon Conference on Glass to be held August 26 to 30 at Meriden, New Hampshire, spoke briefly about the program arranged for this interesting summer session. The general theme of the conference is to be "Rate Processes in Glass". Various authorities in the field will speak on such subjects as mass transport, viscous flow, dielectric Processes, and damage due to high energy radiation. Those wishing to attend should write to Professor George Parks, Department of Chemistry, University of Rhode Island, Kingston, Rhode Island.

The next paper of the morning session was, "Intimate Mixing in Glass Batch Preparation," by Robert P. Bremner, T. L. Smith Company, Milwaukee, Wisconsin. The mixing and blending of dry batch by cross-current and by lift- and drop-procedures was discussed in relation to avoidance of segregation at the dog house.

There are three recognized types of drum mixers that are considered both good and economical. These are all closed drum types but all vary in the way in which they handle a random mix.

First, there is the plain cylinder type on which the batch materials are introduced through one end and discharged from the other end of the drum. There are both mixing blades and discharge buckets attached to the walls of the drum. The blades set up flow action, but in one direction only, and the buckets discharge the batch.

Second is the double-cone drum type that tumbles end over end with no mixing blades or buckets of any kind. Both ends are closed tightly so that there is no dust problem. With this type, the batch changes positions only twice to each revolution of the drum as against six to twelve changes in other drum types.

The drum must be revolved slowly enough to allow gravity to act on the sliding materials. It will generally produce only about six to eight batches per hour, which is not fast enough for big production.

Third is the double-cone type with open ends and revolving on the long axis of the drum. This type has blades to set up flow action but no buckets for discharge. The blades are semi-opposed to each other to produce counter cross current mixing action.

The first and third types must be considered if the

Attending the Glass Division Officers Luncheon at the 59th Annual Meeting are: left to right, Charles H. Greene, Howard R. Swift, F. V. Tooley, Charles P. Spencer, Thomas H. Davis, Frank R. Bacon, Orson L. Anderson, J. Earle Duncan, J. R. Hensler, Leonard G. Ghering, C. L. Babcock, Howard R. Lillie, Robert A. Cameron, and Paul M. Sutton.

interest lies in big production and automatic plants.

The mixing and blending of various type mixers was discussed in relation to the avoidance of segregation. The importance of avoidance of segregation was stressed, as well as the fallacy of weighing glass batches to extreme accuracy and then deliberately mixing in a defective mixer that causes segregation.

The next paper, "Fundamental Studies on the Glass-melting Process. I. Reaction Mechanisms in the Dissolution of Silica by Silicate Melts," was written by C. L. McKinnis, Owens-Corning Fiberglas Corporation, Newark, Ohio, and J. W. Sutton, Denison University, Granville, Ohio, and presented by Mr. McKinnis.

This paper attempted to present a concept of melting which is believed to be as highly important as any study of thermal treatment. Published data on the kinetics of the dissolution of silica by silicate melts have been examined with the aim of developing suitable mechanisms for this reaction. In order to account for the reported change in mechanism with temperature, a process of degradation and reorganization of silicate structural units is proposed to occur as the temperature of a silicate melt is elevated into the regions employed in practical glassmelting.

The process involved: (1) diffusion of highly mobile cations, (2) rupture of Si-O bonds, (3) coupling of the resultant triply coordinated silicons of the lattice with a previously non-bridging oxygen in the melt, and (4) repetition of this sequence at a number of neighboring sites or locations.

The plausibility of this proposal is demonstrated on the basis of thermodynamic and kinetic considerations. The conclusions drawn from this new theory are found to be in qualitative agreement with several aspects of commercial glassmelting practice, as well as with the published experimental data.

The business meeting of the Glass Division consisted of a resume of the efforts of the officers for the past year and was led by J. Earl Duncan, Chairman of the Division.

The Committee on Standard Glasses, Chairman, Clarence H. Hahner, National Bureau of Standards submitted a plan for making a set of new standard glasses that would provide new data on physical properties.

The next International Congress on Glass will be held in Germany during the summer of 1959.

The new officers for the year are: Trustee: Leonard G. Ghering, Preston Laboratories, Box 149, Butler, Pennsylvania, (1959) Chairman; Orson L. Anderson, Bell Telephone Laboratories, Murray Hill, New Jersey; Vice-Chairman: Neill M. Brandt, Mellon Institute, Pittsburgh, Pennsylvania; Secretary: Fay V. Tooley, 611 W. Oregon, Urbana, Illinois (University of Illinois).

O. L. Anderson, the new chairman, announced the following committee members for the coming year: Program Committee: J. R. Hensler, Chemical Research Laboratory, Bausch & Lomb Optical Company, Rochester, New York, Ralph K. Day, Libbey-Owens-Ford Glass Company, 1701 E. Broadway, Toledo 5, Ohio, R. M. Witucki, Corning Glass Works, Corning, New York; Membership: John C. Turnbull; Division Nominations: F. W. Mowery, H. C. Hafner, G. L. Kalousek; Classification and Nomenclature: H. R. Swift; Research: W. R. Prindle, P. M. Sutton, H. T. Smyth; Rules: S. R. Scholes, Fay V. Tooley; Standards: Sam G. Spinner, Fay V. Tooley; Advisory: A. C. Siefert, H. E. Simpson, C. E. Leberknight.

It was also announced that the Fall Meeting of the Glass Division will be held at Bedford Springs, Bedford, Pennsylvania, on October 17-18.

The next paper, "Glass Flow Through Continuous Tanks," was presented by A. R. Cooper, Massachusetts Institute of Technology, Cambridge, Massachusetts. Previous investigations of glass flow through continuous tanks were reviewed. Data were analyzed to show the effect of mixing of raw batch and the flow of glass through the tank and discharge from the end.

Flow of glass through tank was analyzed as follows:

(1) Turbulence owing to gas evolution.
(2) Turbulence owing to thermal convection and density variation in glass.
(3) Turbulence owing to motion incited by charging mechanism.

An analogy was made to flow of oil in a pipe line in which turbulent flow and viscous flow were distinguished. The similarity of flow of glass in a tank was pointed out. A plot of the calculated velocity of glass in a half-section through the tank showed high velocity at top and rapidly decreasing flow toward bottom and corners.

Mixing influence by flow rate through the tank must be highly important, and with increased pull this influence becomes increasingly important. It was hoped that the data collected may result in improved tank design and operation.

The afternoon session was directed by J. R. Hensler, Bausch & Lomb Optical Company, Rochester, New York, who acted as chairman.

The next paper, "Optical and Physical Properties of Some Calcium Aluminate Glasses," was written by H. C. Hafner, N. J. Kreidl and R. A. Weidel, Bausch & Lomb Optical Company, Rochester, New York.

This paper, presented by Mr. Weidel, was enhanced by some excellent color slides. Such splendid presentation is to be encouraged, and the use of this type of slide would improve the presentation, clearness, and understandability of all papers.

There have been developed some calcium aluminate glasses containing alkali oxides and iron oxide. Such glasses were shown to transmit infrared radiation to about 6 microns. These glasses may be competitive with crystalline materials in the field. The glasses were developed by exploring the useful fields of glass formation in the CaO-Al_2O_3-BaO system and then studying the effects of the addition of alkalies, especially Na_2O and K_2O. Coloring oxides were also found beneficial, especially iron.

Many physical properties such as refractive index, density, expansion, Young's modulus, rupture modulus, fracture velocity, Knoop hardness, and some electrical properties were studied. The glasses had poor durability when exposed to high humidity. Anti-reflecting films, however, such as magnesium fluoride, tended to improve the durability and preserve the surface.

The next paper was "Constitution of Sodium, Potassium, and Lithium Phosphate Glasses," by A. E. R. Westman, Ontario Research Foundation, Toronto, Ontario, Canada, and P. S. Gartaganis, Dow Chemical of Canada, Ltd., Sarnia, Ontario, Canada. This paper, presented by

(*Continued on page* 346)

Studies of Fuel Savings in Glass Melting Furnaces

By THOMAS P. COYLE

Maryland Glass Corporation, Baltimore, Maryland

Some twenty or so years ago, refractories manufacturers, through their engineering departments, began a program of improving their products, both in chemical and physical properties. Better regional types of clays and additive oxides are used to fortify chemical composition. Controlled grain sizing and increased firing for lower porosity are employed for better physical stability in burned refractories and higher mechanical force per square inch is used for unburned chemically bonded materials, all of which has resulted in refractories of greatly increased densities.

These improvements incorporated in present day refractories, in conjunction with the advances in furnace design and construction, have considerably extended furnace life and have permitted many more tons of glass to be pulled from each furnace unit.

However, increases in the densities of the respective refractories have resulted in a proportional percentage increase in the thermal conductivity factor for each material, which has caused a substantial increase in the idle-load requirements for each furnace.

The most important refractory development which is responsible for longer furnace life and increased production, is the fused cast materials. These refractories possess a very high thermal conductivity factor and have the best erosive resistance to glass and batch attack, and perform well above the glass line in the most critical spots. But the needed balance for good furnace life and fuel economy demands the services of improved flux blocks: sillimanites, silicas, basic materials, superduty fire brick and the zircons.

The B. T. U.'s or fuel necessary to maintain a furnace at its operational temperature without the feeding of batch or pulling of glass is quite high. This, coupled with the constantly mounting cost over the years of fuels, coal, oil and natural gas, has created a problem of paramount concern to the glass manufacturing industry. Also, the increased demand in fuel input has caused an extra wear and tear burden to be added to the furnace operation from the very beginning.

During this same period of time, furnace engineers began applying 444 silica insulating brick to furnace crowns, 2400°F and 2600°F insulating fire brick to port necks, arches, regenerator walls and, in some cases, to flux bottoms. Silica crowns dripped badly; port necks, arches and regenerator walls slagged or spalled causing the checkers to clog much sooner than in former practice. The transition layer on top of the flux blocks floated to the top of the glass which caused many scum stones and cord to be drawn out with the glass streams or gobs. These furnaces employed flames from the fuel burned as a medium of heating the glass surface.

The applied insulating brick causes the specific refractory material to become red hot through its entire thickness and through the insulating material, except for about 2½ inches from the top of the brick with a differential drop in temperature from approximately 1600°F to 1800°F with an interface temperature from 2600°F to 2850°F for certain sections of the furnace.

The fuel saving compared to prior use for each furnace, before the insulating brick was applied to each section, was very little. An insulated silica crown decreased the fuel input by one-half of one per cent and about the same percentage for other parts of the furnace which were insulated.

This insulating idea was in most cases discontinued and applied only on lower sections of regenerator walls to control the ambient temperatures for more comfortable working conditions.

During the past ten years, the fuel efficiency of furnace checkers has undergone experimentation in order to determine which type and design would bring about maximum fuel economy, or the lowest number of gallons of oil or cubic feet of gas required to melt a ton of good glass. Several different kinds of settings were constructed

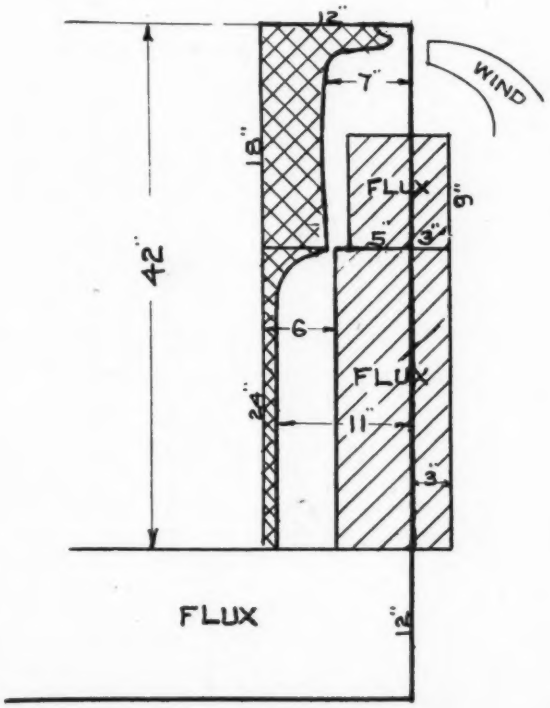


Fig. 1

and studied with respect to vertical flue areas, volumes and total mass versus surface exposed. These follow.

A 6 inch x 6 inch vertical flue conventional setting using both 3 inch thick basic and superduty fire brick; a 6 inch x 6 inch all basic basket weave with the same setting using superduty fire brick constructed under the basic brick; a 4½ inch x 4½ inch setting constructed in the same arrangement as mentioned above which has the lowest mass to surface exposed using both 3 inch and 4 inch thick brick; a 6 inch x 9 inch in a semi-basket weave with 21 courses of 3 inch basic brick constructed on top of 21 courses of 3 inch thick superduty fire brick and a 6 inch x 6 inch this in same semi-basket weave construction which operated over five-and-a-half years without any repairs made to this checker setting.

The smaller vertical flue checkers resulted in lower stack temperatures, but very little fuel saving was obtained over the larger checker openings because with the 4½ x 4½ inch settings not all the checker mass is utilized since the lower part seems to remain cold and the smaller openings seem to cause considerable combustion gas pressure to be built up under the regenerator arches and caps and quite a back pressure in the furnace proper, causing more lost heat through these areas.

Using smaller openings in checkers where the total volumes are under standard size for each furnace requirement: the openings will decrease the fuel efficiency very quickly when some of the openings of the checker become somewhat clogged; the fewer vertical flue openings that remain must deliver the same volume of combustion gases to the flues thereby causing increased velocities and high stack temperatures. This would not be too apparent with larger checkers.

The larger vertical flue openings in a semi-basket weave using 3 inch thick basic over superduty fire brick such as 6 inches x 6 inches, 7 inches by 7 inches, or 6 inches by 9 inches are more economical in large or small volume checkers since, besides offering much less difficulty in keeping the opening clean, the top courses of basic brick receive the high fire rap of the outgoing combustion gases and permit the lower conventional superduty fire brick courses to absorb the secondary heat by permitting the gases to evolve to all the surfaces of the brick exposed.

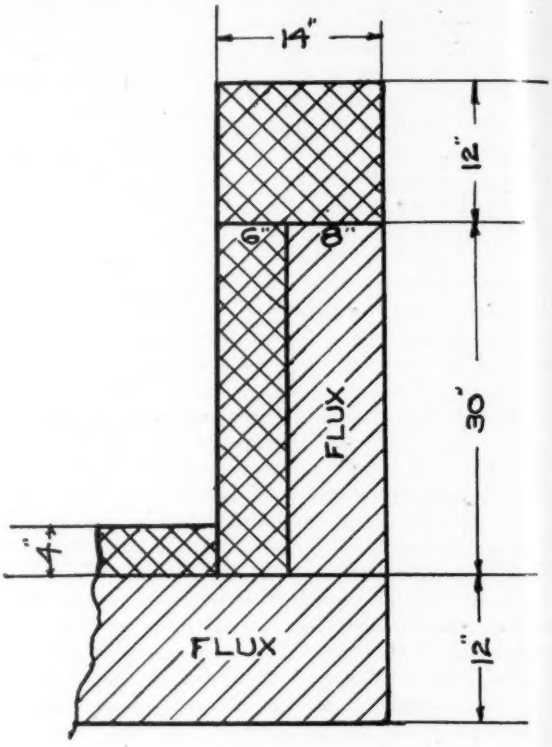


Fig. 3

This type of checker having a larger storage of surface heat would permit the secondary air for combustion to have a substantially less differential drop in temperature for the entire turn-over cycle, usually fifteen minutes. This checker mass is very favorable to surface exposed.

The theory for an ideal sized checker is that the height, length and depth computed in cubic feet should be six-and-a-half to seven times larger than the square foot melting area of the furnace in both side and end port regenerators. This checker volume, when properly constructed, in type and design, can be the most important part of the furnace for increasing overall economy. Checker volumes and the ratio of tons of glass in the melting chamber in relation to the linear feet of side wall blocks exposed to the glass are the reasons for economies effected with larger furnaces.

For the past three years, aluminum sheets, plain or bolted to asbestos transite board, were experimented with to determine how much lost heat through crowns, superstructure, side wall blocks, flux bottoms and ports could

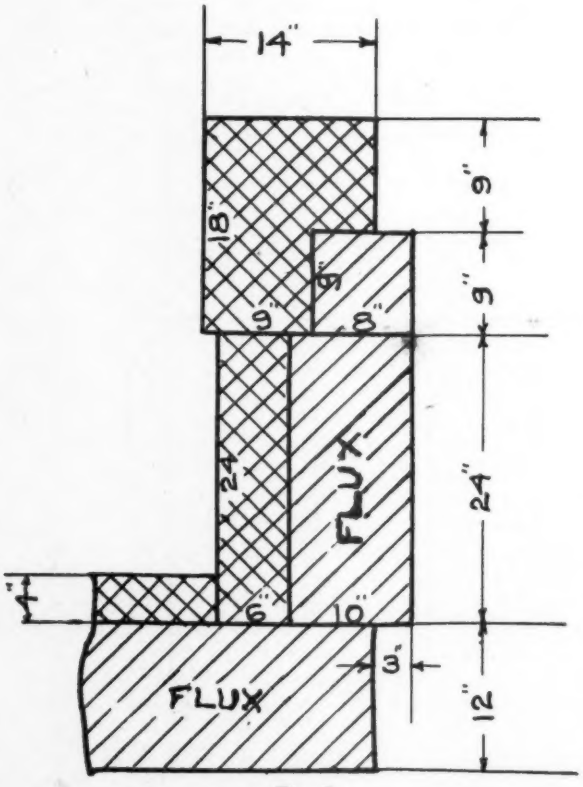


Fig. 2

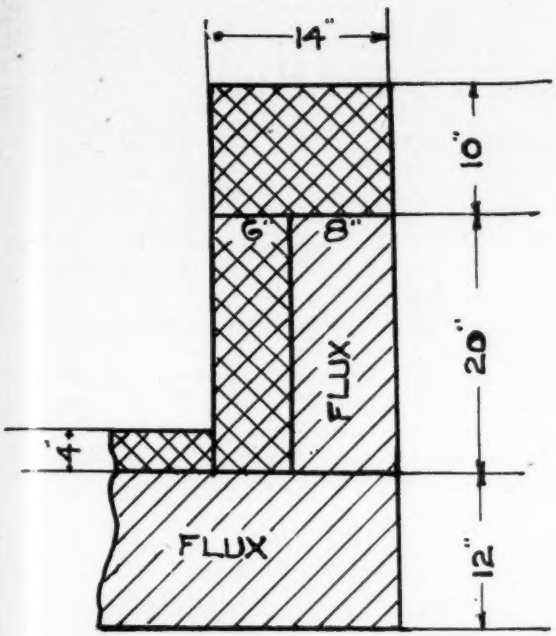


Fig. 4

be saved by controlling the ambient temperature about a furnace. These sheets bolted to transite board ¼ inch thick were constructed against the fused cast side wall blocks of a flint furnace for many months. There was no appreciable decrease in the fuel using this application.

These same type aluminum panels were applied under a four year old flux bottom operating in blue glass. The glass above this flux bottom became so hot it began dripping through the block joints. These panels were placed over basic port arches and necks which caused the basic material to spall more than usual. They were then sealed in 3 inches above the silica crown at the first port section. After a few months, it appeared that the silica crown was running more than normal. These same 3 inch sealed in aluminum sheets without the asbestos board were relocated on the silica crown to the third port area. The temperature of the crown surface before the sheets were applied was 400°F; after three or four days, the surface temperature under the aluminum sheets was 590°F and on top of the sheets, the temperature was 180°F.

These aluminum sheets and panels are very effective in controlling the ambient temperatures around a furnace, so that with proper construction, from 6 to 12 inches air space, and enough coverage, a good percentage of fuel can be saved and will help to diminish the infiltration of cold air and heat loss through cracks and openings which occur from the expansion and contraction of load changes during the operation of a furnace.

A constructive study was made on furnaces operated during the late 30's and the early 40's built with Pittsburgh pot side wall blocks and bottoms; refractory port bottoms and tucks; silica breast walls; silica crowns and silica back gable walls, throats and dog-house corner blocks were standard Corhart material. The checkers were constructed with 6 inch x 6 inch vertical flues using first quality conventional brick 9 inches x 4½ inches x 3 inches. Even though the operating life was from 12 to 14 months, the tons pulled were approximately 40 per cent less than present day pulls and the operating temperatures were not as high, the idle-load fuel requirements were very low and required only 50 gallons of oil per ton of glass for a 50 ton pull from a furnace whose melting chamber was 392 sq. ft.

To regain and apply some of these features for better fuel economy, furnace sections were being balanced out. Back walls constructed with sillimanite and first quality fire brick backing; fused cast port bottoms and tucks backed up with fire brick; fused cast breast walls with 3 to 5 inch fire brick for backing around the first and second ports and the other sections of the furnace constructed with sillimanite and silica. Three and four

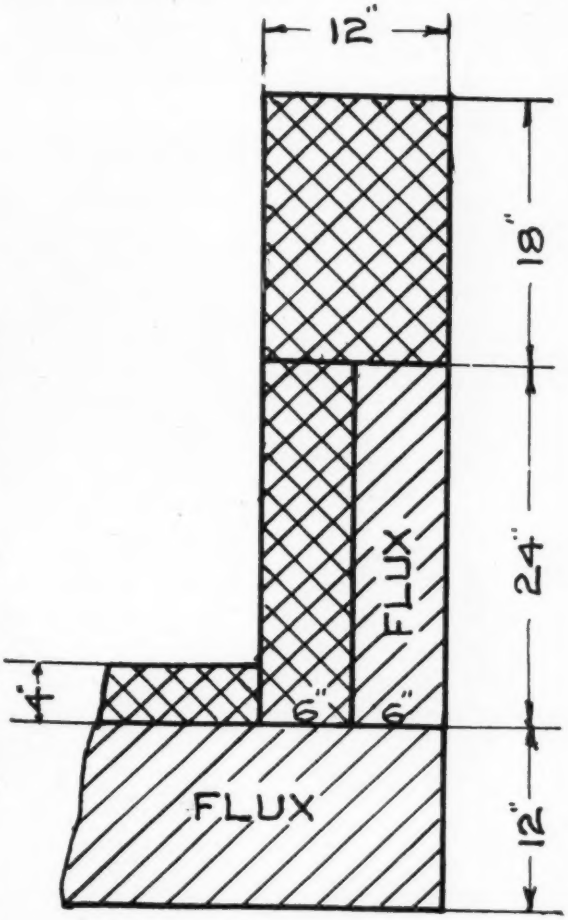


Fig. 5

inches of fused cast paving blocks laid on 10 inches to 12 inches of flux bottoms in conjunction with these side wall construction schemes.

Fig. 1 illustrates a two course fused side wall construction using 12 inch thick by 24 inch high blocks on the lower course and 12 inch thick by 18 inch high blocks on the top course. The dark crossed line section on the inside face represents the amount of block which was eroded away after 32 months of operation, melting flint glass. The curved white section with 3 inches of material left

(*Continued on page* 342)

Miniature Portraits in Glass Rods

By ALBERT CHRISTIAN REVI

Dallas, Texas

The first portrait rods had their genesis in ancient Palestine about the 2nd-1st century B. C. At that time Syrian and Jewish glassworkers were producing rods of glass with miniature portraits traversing the length of the rod. Cross-section disks cut from these rods were used to make beads and other jewelry. Crude as these portraits may seem to be when compared to the 19th century rods we shall discuss later, they were nevertheless honest attempts at producing good likenesses even to the use of color for the lips and hair. The obvious efforts to define such features as the nose, mouth, hair, eyes and brows were remarkable accomplishments for this early period in glass history.

About 1845 Pietro Baggliagi, a Venetian glass manufacturer, produced at his works in Murano millefiori articles in which he used portrait rods, silhouette rods and the conventional millefiori rods. The Baggliagi portrait rods were crude, not much better than the ancient Syrian and Jewish rods. The portait rods produced some twenty years later show a marked improvement.

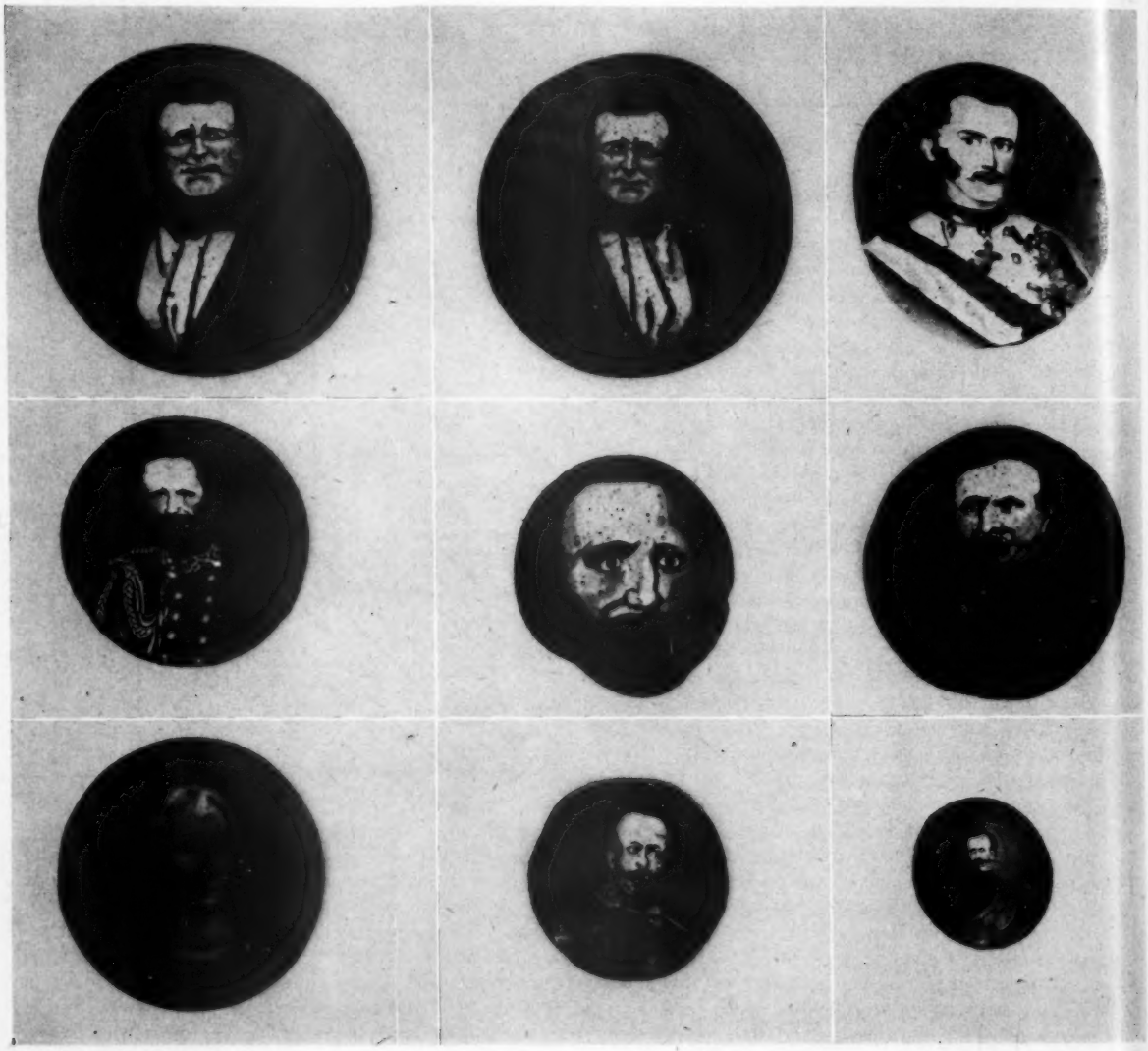


Fig. 2. Top, left to right, Cavour, Cavour, Prince Eugenio of Savoy. Center, left to right, Garibaldi, Garibaldi (unfinished), LaMarmoro. Bottom, left to right, Columbus, Victor Emanuel II, LaMarmoro. *Collection of Pauly & Company, Venice, Italy.*

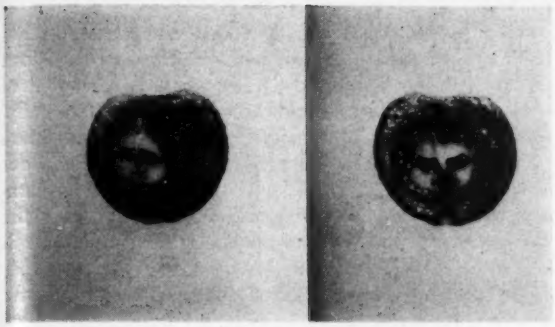


Fig. 1. Portrait bead, front and back. Roman 1st Century B.C.—First Century A.D. *Courtesy of the Metropolitan Museum of Art.*

In 1869 two Venetian glassworkers named Franchini and Moretti produced portraits in rods of glass the physical details of which were remarkable indeed. Some examples of the rods, or "murrina" as they are called by the Venetians, are shown in figures 2 and 3. The portrait rods of Columbus and Victor Emanuel II (Fig. 2, bottom row left and center) have been positively identified as Moretti's work. The portraits of Cavour, Garibaldi and La Marmora (Fig. 2, top row left and center are Cavour, Garibaldi center row left and center, La Marmora extreme right of the center and bottom row) have definitely been established as Jacopo Franchini's handicraft. The remainder of the portrait rods in Figures 2 and 3 are most assuredly the work of either or both of these artisans.

The molecular constitution of Venetian glass is such that it will melt or fuse at a comparatively low temperature. This factor allowed a freedom of manipulation not obtainable with heavier metals such as flint or lead glasses.

In producing portrait murrini the various features of the physiognomy and costume were made up separately, the separate parts being composed of tiny glass rods of various shades and colors no thicker than the lead from an ordinary pencil. These tiny colored rods of glass were arranged and bound together before being subjected to heat which fused the rods into a single unit. These separate units, while still in a plastic state, were drawn out into long rods, diminishing in size but always retaining their original design and shape. The facial features, eyes, nose, mouth, beard or mustache (see Fig. 5), were placed in position in a mold and the rest of the countenance filled in with tiny flesh colored rods of glass. As many as four different skin tones were used giving the finished portrait a realism never before attained in a glass rod.

The costumes were also composed of separately made parts (see Fig. 6). These parts were arranged in a mold with the face and the uniform coloring filled in with tiny glass rods. When completely assembled the mold and its contents were subjected to intense heat which fused the rods and the separate parts into one unit. The completed portrait rod, before it was pulled to a great length and made dimunitive in detail, was about two to three inches long and about the diameter of a half dollar. In making the rod smaller the features remained exactly the same even though the rod itself was drawn out to a length of some 15 to 25 inches and was no thicker through than a pencil.

Fig. 3. At left, Garibaldi. Right, top, Garibaldi (unfinished). Below, LaMarmoro. *Pauly & Company, Venice.*

If it were possible to examine at close hand the unfinished portrait of Garibaldi shown in figure 2, center row, center rod, one would discover that the beard and hair are composed of tiny curls in three shades of brown. The rods that were used to make up the beard and hair, when examined under a strong glass, are seen to be made somewhat like a jellyroll cake. The effect is amazingly

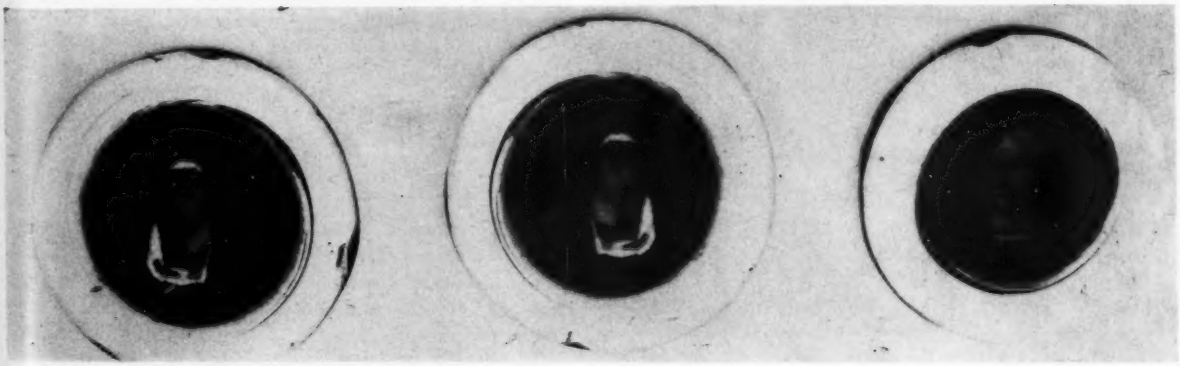


Fig. 4. Left to right, obverse and reverse of a cross-section disk, probably an attempt to reproduce a likeness of the Virgin Mary; Portrait of Columbus. *Pauly & Company, Venice.*

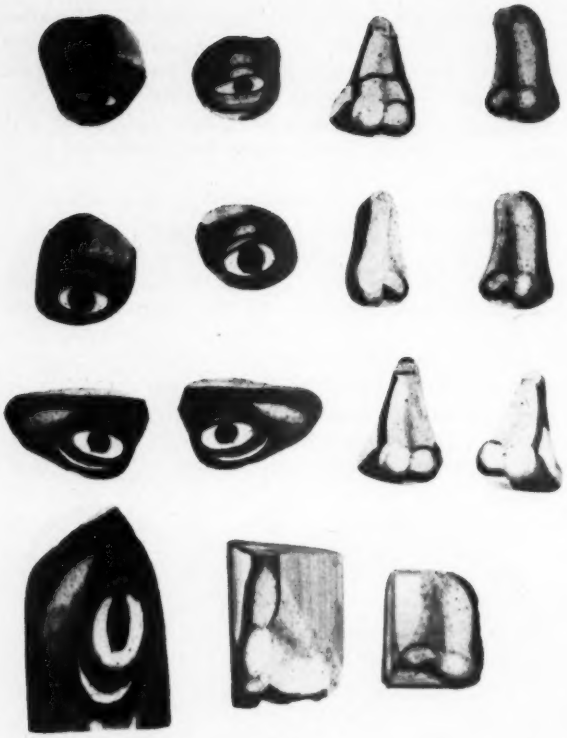


Fig. 5. Cross-section pieces used in making up the faces in the portrait rods, i.e., eyes and noses. *Pauly & Company, Venice.*

Fig. 6. Cross-section pieces used in making the details of the uniforms in the portrait rods. *Pauly & Company, Venice.*

realistic.

The Peacock rod (see Fig. 7) was quite an accomplishment and required not less than 35 different operations to complete it. Each of the tail feathers is composed of several small rods in a multitude of colors. The body, feet and head are also made up from numerous glass rods alive with vibrant colors. The finished rod is about an inch in diameter; it was at least three inches in diameter originally and was reduced in size by drawing the rod out to a length of approximately 15 inches while it was still hot and in a plastic state.

The portrait rods were considered works of art and cross-section disks were sold to be set into gold jewelry, or several were arranged in a fitted velvet box for display. It is quite probable that sections of these rods were used in paperweights which were enjoying a wide popularity in that period. The small scent bottle shown in Fig. 8 is the only such article known to the writer in which these rare portrait rods has been found.

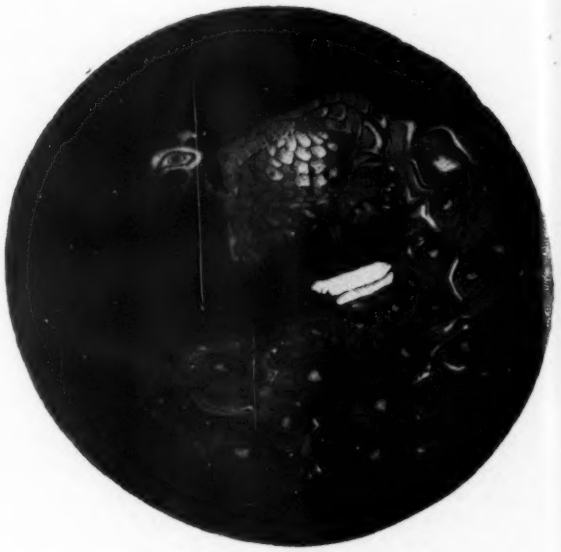


Fig. 7. Peacock portrait rod. *Pauly & Company, Venice.*

In 1921 Pauly & Company of Venice, Italy was selling small sections of some of the Franchini and Moretti portrait rods. The following prices have been taken from Pauly's records of that year.

Cavour	by Franchini	Lire	150.00
Garibaldi	" "	Lire	150.00
LaMarmora	" "	Lire	150.00
Columbus	" Moretti (rare)	Lire	250.00
Victor Emanuel	"	Lire	100.00

The total collection of five, boxed for display, sold for Lire 800.00 in 1921. The cost of reproducing these same rods today has been conservatively estimated by Pauly & Company at about Lire 150,000 ($240.00 at the present rate.)

The set of portrait rods now housed in the Smithsonian Institution in Washington, D. C. as a part of the

(*Continued on page* 344)

Corning Introduces Pyroceram: Crystalline Material Formed from Glass

On May 23, Corning Glass Works announced the discovery of a new family of basic materials harder than high carbon steel, lighter than aluminum and up to nine times as strong as ordinary plate glass.

The announcement came at the beginning of an excellently-planned four day program to celebrate the completion of Corning's new research and administration center, Houghton Park.

Pyroceram is the name given by Corning to these extremely hard, fine-grained crystalline materials formed from special glasses. An entire family of the new materials, with a wide range of physical properties, is being developed.

Pyroceram is claimed by Corning to be one of the greatest technological advances in glass research since the discovery of heat-resistant boro-silicate glass early in the twentieth century. The family of new materials was invented by Dr. S. Donald Stookey, manager of Corning's fundamental chemical research department. Dr. Stookey has been responsible in the past for the invention of many of the company's photosensitive glasses.

In his introductory remarks, Dr. William H. Armistead, company vice president and director of the research and development division, stated, "Pyroceram materials exhibit common characteristics of high mechanical strength, excellent electrical insulating properties, high deformation temperatures, good thermal shock resistance, and hardness." The materials can be individually formulated to have these qualities.

Pyroceram is essentially a crystalline material formed from a non-crystalline glass. A glass batch containing one or more nucleating agents is melted, formed and cooled. Subsequent heat treatments cause the nucleating agents to form billions of submicroscopic crystallites per cubic millimeter in the Pyroceram, each crystallite acting as a center of crystal growth as the heat continues. By controlling the chemical composition and growth of these crystals Pyroceram is made with a variety of properties.

The end product, after heat treatment, is a fine-grained crystalline material, nonporous and harder than most ceramics and many metals.

Pyroceram can be tailor-made with thermal expansions ranging from slightly negative to high enough to match those of heavy metals. It can have electrical insulating properties superior to those of the best commercial dielectric ceramics. It can be made opaque or it can be transparent, the first polycrystalline material ever to exhibit this optical property.

Experimental Pyroceram compositions have flexural strengths as high as 60,000 pounds per square inch. The strength-to-weight ratio of one Pyroceram is identical

Pyroceram has no recorded loss of strength at temperatures as high as 1470 degrees F. This Pyroceram is still rigid after furnace temperatures hot enough to melt copper bar, cause steel bar to sag.

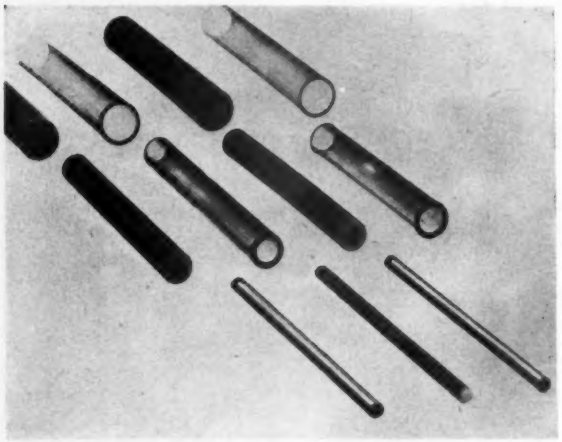
to that of annealed aluminum, greater than that of titanium and stainless steel. Certain types of Pyroceram keep their strength at temperatures as high as 1300°F. With its high strength-to-weight ratio, lightness and excellent thermal characteristics, Pyroceram has potential use as a substitute for aircraft metals.

"Unlike most high-strength, high-temperature crystalline materials," said Dr. Armistead, "Pyroceram has great flexibility in forming. It can be made into large

Versatility of new material is illustrated with the varied forms shown. Large container was blown; shallow dish was pressed. The tube was drawn from this new material; odd-shaped blade in foreground was made by investment casting techniques.

or complex shapes by any of the known glass-forming techniques. It is adaptable to mass production, and can be pressed, drawn, blown, rolled and centrifugally cast."

Another advantage in formability, Dr. Armistead added, is the fact that certain types of Pyroceram can be formed by investment casting techniques such as those used in metal foundries, enabling it to be fashioned into complex, close tolerance parts.



Both rod and tubing of various diameters and wall thicknesses can be made from Pyroceram. Shown are pieces of this new material in its glassy state (clear) and its crystalline state, after firing.

One Pyroceram developed by Corning is lighter than aluminum and has a flexural strength of 40,000 pounds per square inch. "This Pyroceram," said Dr. Armistead, "is presently being developed as the material for missile radomes." The cone of Pyroceram protects the sensitive directional instruments in the nose of the missile from the sudden high temperatures experienced in hypersonic flight. The softening point is 2460°F., which is above the melting point of some stainless steels.

Thermal shock resistance of some of these new crystalline materials is greater than that of dense alumina and equal to that of fused silica. The resistance of one Pyroceram to acid and alkali attack is nearly as good as that of Pyrex brand borosilicate glass.

While more than 400 types of Pyroceram have been experimentally melted, only four have been fully investigated and melted in pilot runs to date. Two of them, Pyroceram Code Numbers 8607 and 8608, are handled and formed in their glassy state similarly to borosilicate glass. They can be formed by conventional glass-forming methods.

The two other Pyroceram materials, Code Numbers 8605 and 8606, are very fluid at high temperatures, and can most easily be formed by centrifugal casting. Experiments indicate that these latter two Pyroceram materials lend themselves to forming by investment casting techniques. Pilot runs indicate that all four of these new materials are adaptable to mass production techniques.

In discussing the probable cost of the new material William C. Decker, president of Corning, said, "As this material has not yet been manufactured except in our pilot plant, we have little cost data so far. The probability, however, is that Pyroceram, while more expensive than glass, will be much less costly than, for example, stainless steel. Pyroceram has two substantial cost advantages: batch materials going into Pyroceram are not costly, and it can be shaped while molten by regular glassmaking processes."

The following day Corning Glass Works entertained representative groups of employes and civic leaders from Corning and eleven other communities where the company maintains plants. The guests were taken on guided tours and attended the dedication dinner.

On Saturday, May 25, the new buildings were dedicated to the employes in a brief ceremony and on Sunday, residents of the Corning area were invited to inspect the new buildings.

These buildings have added nearly a quarter-million square feet of floor space to office and laboratory facilities. They form a landscaped architectural grouping with the adjacent Corning Glass Center. The new group of structures includes: the nine-story administration building and the three-story research laboratory, exteriors of both faced with black Carrara glass and vertically accented windows; the one-story development workshop which is faced with glass brick, encloses an open work area with offices on a mezzanine floor; the new cafeteria, with contrasting oval shape, white Carrara glass facing and concave roof. A reception lobby connects the administration building, research laboratory and cafeteria. The research laboratory and development workshop have been named the Eugene C. Sullivan Research Laboratories in honor of the man who is known as the founder of organized glass research in this country. Dr. Sullivan is honorary chairman of the board of directors of Corning Glass Works.

Contrasting shapes and colors mark these new Corning Glass Works buildings at Houghton Park, Corning, N. Y. At center, foreground is the hung-roof cafeteria, its white glass exterior contrasting with the administration building, rear. The two structures are joined by a long, low reception lobby to the research laboratory, left.

• Stockholders of The Colorado Fuel and Iron Corporation voted at the annual meeting in Denver to re-elect for three-year terms as directors of the corporation: A. C. Bekaert, A. F. Franz, Charles R. Tyson, and W. M. White.

Recent Translations of Russian Papers of Interest to the Glass Industry

Conference on the Structure of Glasses

Five papers presented at a Russian Conference on the theory of glass structure have been published in *Steklo i Keramika (Glass and Ceramics)* vol. 11, No. 3 to 6 (1954).

1. O. A. Esin and P. V. Gel'd. Structure of glasses and properties of molten silicates.

In 1921 Lebedev pointed out that glasses were not structureless liquids, but rather agglomerations of small crystal-like domains with transition layers in between. Later, Lebedev, Stozharov, and Tudorovskaya showed that some properties of glasses (e. g., refractive index) have abnormal temperature coefficients near the temperatures at which transformations occur in tridymite, crystobalite and quartz; thus these crystal modifications of silica are present in glasses. This is confirmed by X-ray diffraction and electron diffraction patterns.

At present, two additional statements can be made, namely that glasses (containing both acid and basic oxides) consist of ions, rather than of molecules or atoms, and that the micro-heterogeneity of glasses is caused by the tendency of "strong" ions (e.g., Fe^{+++} and O^{--}) to associate with each other, while "weak" ions (e. g., Na^{+} and PO_4^{----}) accumulate in another part of the glass.

The ionic structure of glasses is proved by the validity of Faraday's law for their electrolysis. The electric conductivity of glasses is a simple exponential function of temperature; this shows that only one kind of ions conducts current. When the relative amount of alkali oxides in a glass increases, the activation energy for the conductivity decreases (rather than the pre-exponential term); hence, the number of ions carrying the current does not, but the ease of their movement does, increase on addition of alkali.

The "micro-demixing" of ions in glasses is proved, e. g. by the observation that addition of silica to basic silicate melts causes visible demixing which starts at greater percentages of SiO_2 the weaker the potential of the cations.

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2. A. A. Appen. The coordination structure of silicate glasses.

The properties of silicate glasses depend on the coordination numbers of the cations in them. A change in the coordination number accounts, e. g., for the following observation.

When the bivalent metal is varied in glasses containing also sodium oxide and silica or silica and alumina, the refractive index rises from Be to Mg to Ca to Sr to Ba, and the difference between the indices of Be and Ba glasses is relatively large, as shown in Table I.

Table I. Refractive index n_D

Glass	Na_2O 16, MeO 20, SiO_2 64 mol. per cent	Na_2O 16, MeO 20 Al_2O_3 10, SiO_2 54 mol. per cent
Beryllium	1.5178	1.5196
Magnesium	1.5114	1.5236
Calcium	1.5466	1.5517
Strontium	1.5538	1.5578
Barium	1.5719	1.5766

No such regularity is observed in alkali-free glasses, as shown in Table II.

Table II. Refractive index n_D

Glass	MeO 25, Al_2O_3 25, SiO_2 50 mol. per cent
Beryllium	1.583
Magnesium	1.565
Calcium	1.575
Strontium	1.575
Barium	1.590

In this series, the n_D of magnesium, calcium and strontium glasses is less than that of beryllium glasses. This is so because the coordination number of aluminum, which can be 6 or 4, is more likely to be to 4 the more basic the glass, and the n_D of aluminum glasses is lower the smaller the average coordination number.

The coordination number of Si probably is independent of the composition of glass.

The coordination numbers of Al and B apparently affect also some properties of glass melts. Thus, viscosity of $Na_2O.MeO.SiO_2$ melts decreases in the series Mg→Ba, while viscosity of $2\ MeO.Al_2O_3.4SiO_2$ melts increases in this series. Presumably, Al with coordination number 4 causes a higher viscosity than when the coordination number is 6. An analogous effect is observed in the instance of surface tensions. In melts of $Na_2O.MeO.SiO_2$, surface tension slightly decreases from Mg to Ba, while it increases in melts of $Na_2O.MeO.B_2O_3.SiO_2$. Probably, the relative amount of B with coordination number 3 decreases when the atomic weight of the divalent metal increases; as surface tension of boron compounds is smaller when this number is 3 than when it is 4, the increase of surface tension with the atomic weight from Mg to Ba is accounted for.

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3. L. G. Mel'nichenko. Theoretical views of D. I. Mendeleev on the structure of silicates and glasses.

The data are taken mainly from a book Mendeleev published in 1864 on the manufacture of glass.

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4. K. S. Evstrop'ev. History of the development of the hypothesis of crystallite structure of glass.

Papers by A. A. Lebedev (1921), V. A. Florinskaya

and other Russian authors are reviewed. The views of Zachariasen and Warren are criticized.

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5. S. K. Dubrovo and Yu. A. Schmidt. Chemical stability of glassy silicates and sodium alumosilicates.

Samples of glasses, 10-12 sq. cm. in surface area, were annealed and then stirred in a silver vessel for 7-12 hours, after which the concentration of all constituents of the glass in the solution was determined. The composition of the glasses was expressed as $Na_2O.m\ SiO_2$. The results are shown in Fig. 1. Its abscissa shows the mole per cents of SiO_2 in the glass and also the molar ratio Na_2O; SiO_2, and its ordinate represents log n for Na_2O (continuous line) and log (n/m) for SiO_2 (dashes). The n is the number of gram-molecules (moles) leached out in 1 hour from 1 sq. cm. of glass. If this number for SiO_2 is m times that for Na_2O, the glass dissolves without decomposition; therefore, as long as log n for Na_2O is equal to log (n/m) for SiO_2, plain dissolution takes place.

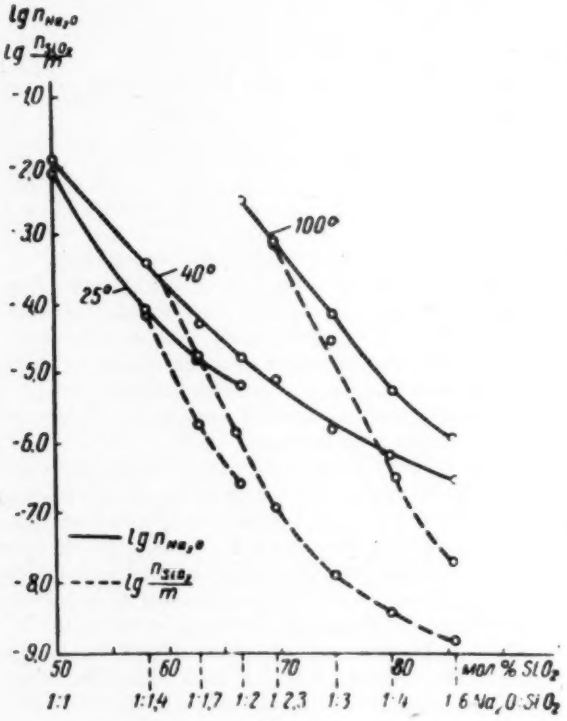

Fig. 1

It is seen that sodium silicate dissolves in water at 25°C as long as the mole ratio Na_2O:SiO_2 is 1:1.4 or less, while Na_2O is preferentially leached out when its concentration in glass is greater. At 40°C, plain solubility is observed at ratios Na_2O:SiO_2 smaller than 1:1.6, and at 100°C the boundary lies at a ratio of 1:2.4.

Fig. 2 brings analogous data for corrosion by 0.1 N hydrocloric acid. The abscissa shows again the mole per cents of SiO_2 and the ratios Na_2O:SiO_2 in the sodium silicate used, while the ordinate is log n for Na_2O, the solubility of SiO_2 in acid being small at all ratios. The lower line 1 is for 1 hour treatment, and line 2 is valid for leaching during 6 hours.

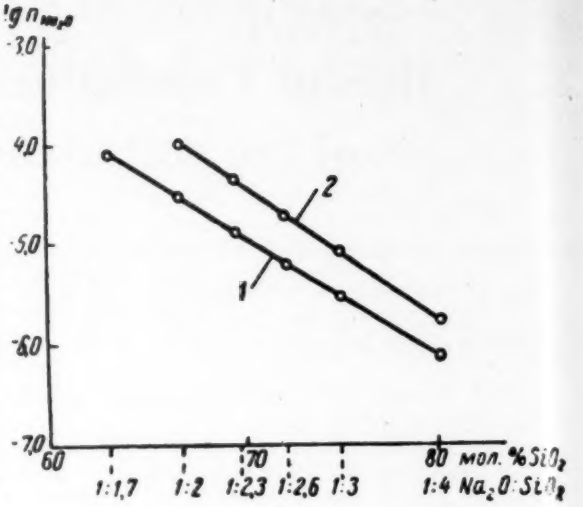

Fig. 2

The main result of the experiments recorded in Fig. 1 and 2 is that chemical compounds (such as $Na_2Si_2O_5$) cannot be detected by corrosion measurements on glass.

The investigation was extended to sodium oxide-alumina-silica glasses. Their composition is expressed as $Na_2O.\ k\ Al_2O_3.\ m\ SiO_2$. Hence, if a corrosive agent ex-

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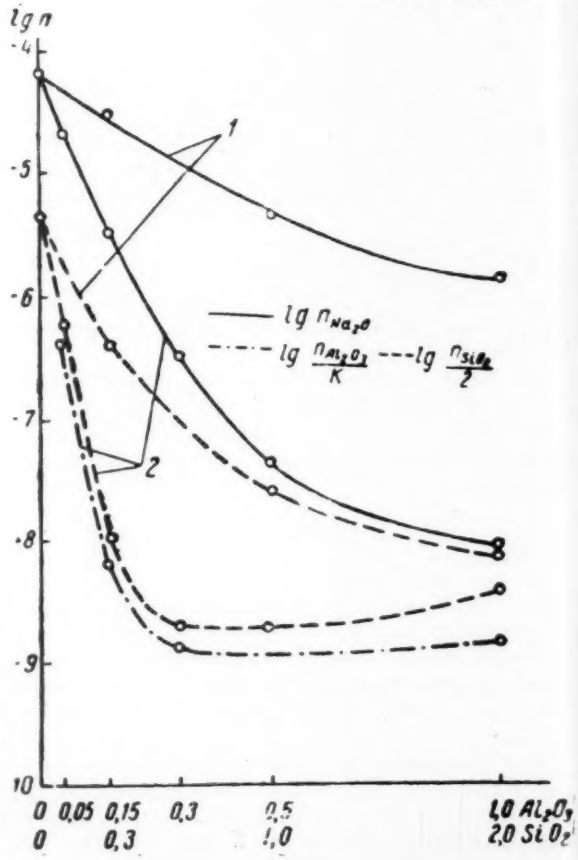


Fig. 3

Inventions and Inventors

Annealing and Tempering

Vertical Annealing Lehr. Fig. 1. Patent No. 2,748,537. Filed April 20, 1953. Issued June 5, 1956. Five sheets drawings. Assigned to Ball Brothers Co., Inc. by Felice G. Pasotti.

This invention relates to annealing lehrs which are provided with new and improved means for establishing and maintaining requisite temperature conditions at different points along the path of travel of articles moving through the lehr.

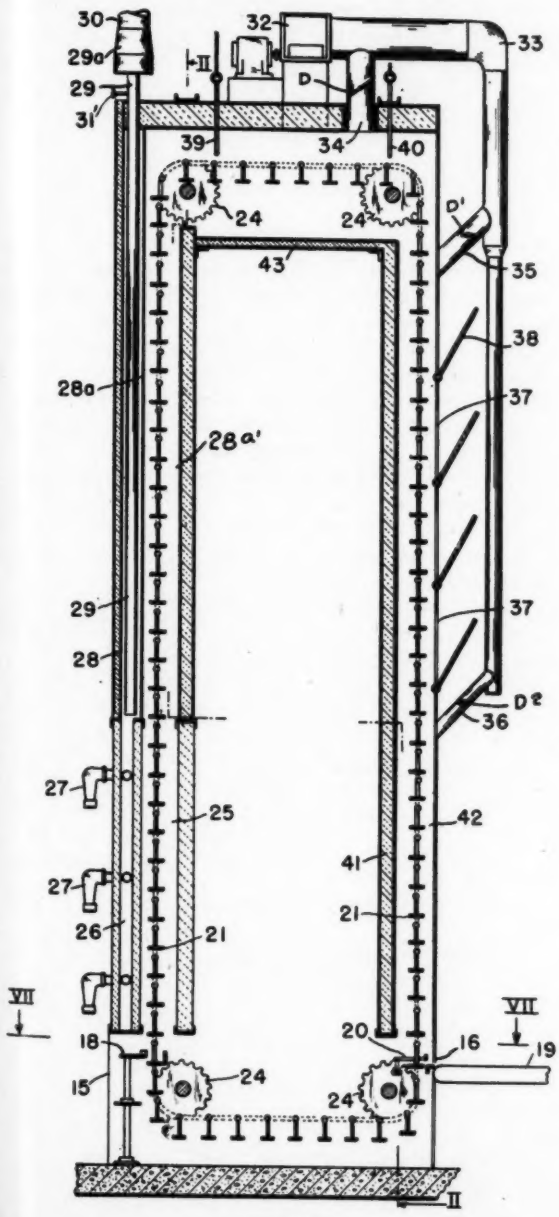


Fig. 1

Referring specifically to Figure 1 the illustrated lehr is a tower-like structure having an article-receiving portal 15 located at one side and adjacent the bottom thereof, through which articles to be annealed are delivered to the lehr. The lehr is also provided with an article-delivery port 16 located adjacent the bottom thereof but on the side of the lehr opposite to the portal 15, and through which annealed articles are delivered from the lehr.

The upper end of the combustion chamber 26 communicates with a chamber 28 which may be termed an exhaust chamber and which may include a plurality of ducts 29 which communicate at their lower ends with the combustion chamber 26 and at their upper ends with a stack 30. It will be apparent that the ducts 29 parallel the passage 25 and are, therefore, so located with relation thereto that, if desired, heat may be delivered from them to the passage throughout the length of the upper portion of the passage.

In order to produce a controlled flow of air within the lehr passages, a motor driven suction fan 32 is employed with the inlet port thereof communicating with the extreme upper end of the lehr and, therefore, with the outlet end of the passage 25 and the inlet end of the passage 42. The outlet port of the fan communicates with a conduit 33 which is provided with branch passages 34, 35, and 36. Each of these passages is provided with a damper for the purpose of controlling the passage of air through it.

One of the important features of the invention is that each tray 21 carries a single row of articles to be processed. All such articles are preferable and normally located centrally between lateral edges of the tray and the row of articles extends lengthwise of the tray. This arrangement of articles and the shape of the lehr passages contributes to a condition such that each article is substantially unaffected throughout the annealing and cooling operation, by the position of adjacent articles.

As the trays swing to positions below their supporting chains 23 and move through the uppermost portion of the lehr, each article carried by each tray is similarly disposed with relation to the surrounding air flow and, consequently, all the articles are equally effected by the conditions encountered in the uppermost portion of the lehr. This is also true of articles as they move downwardly through the passage 42. As a result, all the articles are evenly heated and then evenly cooled as they traverse the passages of the lehr.

There were four claims and the following references were cited in this patent: 1,070,509, Miller, Aug. 19, 1913; 1,554,275, Good, Sept. 22, 1925; 1,738,038, Cope, Dec. 3, 1929; 1,782,481, Shipley et al., Nov. 25, 1930; 1,919,821, Blount et al., July 25, 1933; 2,257,180, Mayer, Sept. 30, 1941; 2,409,300, Miles, Oct. 15, 1946 and 1,912, Great Britain, 1862.

Feeding and Forming

Internal Glass-To-Metal Seal. Patent No. 2,770,923. Filed September 4, 1951. Issued November 20, 1956.

One sheet of drawings; none reproduced. Assigned to Corning Glass Works by Robert H. Dalton and Raymond O. Voss.

The invention relates to an internal glass-to-metal seal which is provided with a metallic electric conductor passing through and hermetically united with the glass body. Such a combination comprises both an internal and an external glass-to-metal seal and is utilized for introduction of leads into hermetically sealed containers of a variety of types, including radio and other electronic tubes or devices having metallic walls.

An especially desirable glass consists approximately of 75 per cent PbO, 11 per cent Al_2O_3, 11 per cent B_2O_3 and 3 per cent SiO_2, which has a working point of about 560°C. and an expansion coefficient of 84 x 10^{-7} per °C.

Preferably the glass is preshaped either by molding while plastic or by shaping in powdered form followed by sintering. The dimensions of such preformed glass body should coincide approximately with the hole in the aluminum member. If the seal is to contain an electric conductor, the glass body should be provided with an opening to permit introduction of the conductor through it; or such conductor may be sealed into the glass body in a prior operation.

To make the seal, the various parts are placed in their intended relative positions and the assembly is heated to above the working point of the glass, care being taken not to melt the aluminum. If the glass body is thick enough to require annealing, the assembly may be cooled slowly to accomplish the same.

There were 5 claims and the following references cited in this patent: 2,210,489, Lemmens et al., Aug. 6, 1940; 2,419,049, Alpert, Apr. 15, 1947; 2,521,846, Gregory, Sept. 12, 1950; 2,534,392, Walsh, Dec. 19, 1950; 2,549,504, Messana, Apr. 17, 1951; 106,837, Australia, Mar. 6, 1939; 583,242, Great Britain, Dec. 12, 1946; 625,466, Great Britain, June 28, 1949, and 634,657, Great Britain, Mar. 22, 1950.

Furnaces

Glass Refining Apparatus. Fig. 2. Patent No. 2,730,338. Filed September 14, 1951. Issued January 10, 1956. Two sheets drawings. Assigned to Pittsburgh Plate Glass Company by Joseph S. Gregorius.

This invention relates to the refining of molten glass to produce optimum homogenization thereof, and it has particular relation to a stirring mechanism designed to effect such homogenization.

In operating the stirrer 50, (See Fig. 2) molten glass is conveyed from a source, such as a melting tank (not shown) through the channel 68 directly into the upper portion of the chamber 60. It is desirable that any atmosphere in the chamber and channel be free from exposure to air from the outside. If desired, the supply of glass can completely fill the channel and chamber under a head of molten glass of appropriate level. As the motors 28 and 35 operate, the shaft 46 is driven in rotation while the frame 12 is vertically reciprocated by actuation of the cam 26 against the roller 25. The molten glass passing through the upper disk is forced downward away from the axis of the shaft while the edges of the disk, including those defining the openings, shear the column of glass passing downward through the

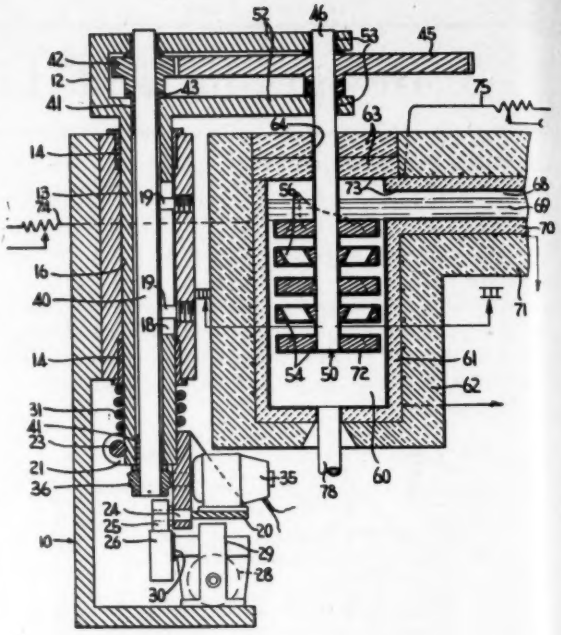


Fig. 2

cylindrical chamber. In this manner, the glass is thoroughly homogenized and formation of undesirable ream and striae is prevented.

There were 6 claims and the following references were cited in this patent: 44,179, Gibson, Sept. 13, 1864; 383,489, Peters, May 29, 1888; 1,116,230, Boyd, Nov. 3, 1914; 1,603,221, Thomson, Oct. 12, 1926; 1,852,218, Peiler, Apr. 5, 1932; 2,470,558, Honise, May 17, 1949; 2,515,478, Tooley et al., July 18, 1950; 2,570,079, Spermulli, Oct. 2, 1951.

Electrode Assembly for Glass Furnaces. Fig. 3. Patent No. 2,736,759. Filed October 22, 1954. Issued February 28, 1956. One page of drawings. Harvey L. Penberthy.

This invention relates to glass furnaces and more particularly to a novel arrangement for mounting and feeding electrodes into such furnaces.

While previous assemblies have been found satisfactory for horizontal electrode mountings it has been found that where the electrode is mounted vertically in the bottom wall of a tank the cooling efficiency of the fluid fed into the

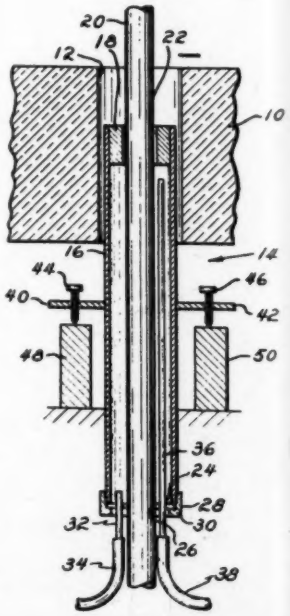


Fig. 3

(*Continued on page* 350)

Effect of Stress and Temperature During Forming on Strength of Glass

As a result of various strength of glass studies it has been suggested that two of the main reasons for variations in strength data are (a) the method of forming the specimens to be tested and (b) the condition accompanying the forming process. For example, Tooley and Stockdale found that the strength of the glass they were working with could be changed by variations in the forming process.

Their results served as the basis of the study reported by Lynch and Tooley in the April 1957 issue of the *Journal of the American Ceramic Society* and which was conducted to determine if the general effect noted in their work, namely, an increase in strength with drawing load, would be observed with increased size of specimens, with a single- rather than a two-stage drawing procedure, and with transverse rather than direct tension breaking.

The mechanical strength of solid materials involves the force required to separate atoms or atomic groups far enough to overcome their attractive forces and thus might appear to be one of the simpler properties of matters. Glasses especially should lend themselves to a theoretical treatment of strength since their properties are independent of the direction of measurement. The forces between atoms in glass can be treated statistically since glasses are isotropic and homogeneous.

Actually, the determination of the strength of solids is not a simple matter, and all solids exhibit average strengths which are considerably less than the theoretical values. Such results indicate that tensile failures are not so much a result of overcoming interatomic forces but are due to the accumulation of stresses at weak points in the structure.

The first explanation for the difference between the measured strength of glass and its theoretical strength was the flaw theory introduced by Griffith in 1920. This original theory has been elaborated by Sack and Elliott.

Several other theories have been presented to account for the low strength of massive glass and for such properties as the delayed elastic effect in glass and the delayed-fracture effect. Cox presents a theory of the strength of glass based on the kinetic energy of the atoms in the structure.

Stuart and Anderson employ the rate process theory to explain the strength of glass under constant load.

Gurney discusses the delayed fracture of glass and points out that it might be due to the gradual spread of Griffith cracks.

Murgatroyd doubts the existence of Griffith cracks as such and notes that he has not been able to find them by any method, although they should be of the order of 10^{-3} cm. in size to account for the strength values found for massive glass. Holland and Turner and Murgatroyd state that a surface scratch must be a certain size before it has any effect on strength. Jones believes that it is dangerous to specify any size for flaws in general and that for any particular type of flaw there is apt to be a relation between size and effectiveness.

The size of specimen used for strength tests has been shown to influence the value of average strength. Bikerman and Passmore tested fibers of various lengths and found that the shorter the specimen tested the greater is the average strength.

The most widely discussed subject in the literature on the strength of glass is the origin of the high strength found when glass is tested in the form of fine fibers. Weyl points out that metals and rubber also show an increase in strength in the fiber form. In these materials this increase in strength can be accounted for by a structural change, but this type of effect has not been proved for glasses. Jones states that in fine fibers surface tension has a greater effect and the configuration temperature is likely to be high owing to the rapid cooling, even after permanent stresses have been removed by annealing. Powell and Preston found that the microstrength of glass is comparable to the strength of small fibers and is twenty to sixty times the macrostrength.

The idea that the strength of glass increases as the diameter of the specimen decreases was pointed out by Griffith and has since persisted and has been confirmed by many investigators.

Slayter suggests that the idea of a decrease in size causing an increase in strength may be replaced by the concept that the rate of cooling for the different sizes is the dominant factor.

Bateson agrees that evidence has accumulated which modifies the Griffith theory and causes the supposed diameter-strength relation to lose significance and become incidental rather than fundamental. He cites the work of Koch and of Anderegg, who studied the effect of diameter and achieved widely differing results.

The idea that the decrease in diameter of a fiber accounts for the increased strength is brought into considerable question by the work of Otto. Fibers varying from 20 to 60 x 10^{-5} in. in diameter and prepared under the same drawing conditions showed no significant change in strength. Preston agrees that differences in forming conditions account for the variation of strength with diameter and cites the work of Otto as supporting evidence that there is no orientation in glass in the fiber form. The work of Tooley and Stockdale shows the important influence of preparation conditions on the tensile strength. In the testing of constricted-rod tensile specimens they found a considerable increase in strength as a result of increased drawing loads in both the first and second drawing operations. Smekal believes that the physical state of a fiber is influenced by three factors in addition to composition: (1) drawing structure, (2) prestressing caused by rapid cooling, and (3) alteration of flaw properties.

In the present work, fibers (0.043-0.045 in. in diameter) were formed by down-drawing cane (Glass Division Standard soda-lime glass) at a constant rate (between 3 and 5 inches per minute), using loads of

from 100 to 8000 grams. This procedure required that a different glass viscosity (glass temperature) be necessary for each drawing load used. The tensile strength of the produced fibers was determined by transverse loading on annealed specimens.

From the results obtained in this study it was concluded that:

(1) The tensile strength of glass was very greatly affected by the conditions accompanying its forming. Any values reported as a result of strength studies should be accompanied by a detailed explanation of the method and conditions of forming. This point requires continual re-emphasis to investigators in this field.

(2) Strength measurements showed that the tensile strength of the fibers increased with an increase in drawing load. In the range used this strength increase amounted to 62 per cent.

(3) This effect of increased tensile strength was found to persist even after the fibers were abraded but its magnitude in this case was only 18 per cent. This indicated the possibility that a portion of the strength increase was due to some factor other than the improvement of the surface as a result of higher stress during forming. Improvement of the surface was responsible for the larger part of the effect.

(4) The changes in strength brought about by mechanical stress during forming were similar to those resulting from thermal stresses.

The changes in properties found in this study indicate that a condition of stress may exist in the glass which is not removed by a normal annealing process. Such a condition could result from the method of drawing fibers which imparts a stress on the glass during its change from the mobile to the rigid state. Apparently the structural units are not able to assume their normal positions because of the drawing force and as a result are in a stressed condition when the glass is rigid. The degree of stress produced in this way would be a function of the load applied during forming. The cumulative result of such stresses is an increase in the tensile strength.

Reviewer's note: It is interesting to note, from a glass forming viewpoint that when the drawing load is plotted against the log of viscosity a good straight line relationship results.

FIBERGLAS CANADA COMPLETES EXPANSION PROGRAM

Fiberglas Canada Ltd., has announced completion of a $450,000 expansion program at its Guelph and Sarnia plants in Ontario.

The Guelph expansion will allow the company to produce fiberglass reinforced plastic products and a new line of acoustical products. The Sarnia enlargement will increase operations for production of fibreglass pipe covering by about 50 per cent.

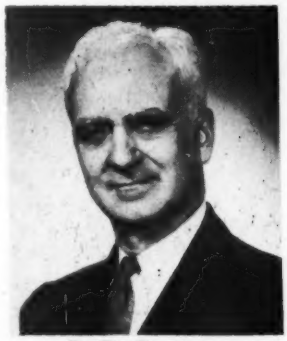
CANADIAN GLASS INDUSTRY TOPS ALL PREVIOUS RECORDS

An all-time record has been reached by the glass and glass products industry of Canada in the latest annual survey of such operations just revealed by the Canadian Government. The survey shows that the factory value of shipments in this industry soared up to a new record of $80,830,622 in 1955 from $67,988,201 in the preceding year. This represents a gain of practically 19 per cent and almost 11 per cent over the previous record of $72,910,00 in 1953. A decade ago this Canadian industry reported 103 establishments with gross selling value of products at only $28,281,397, emphasizing the spactacular progress in the glass industry in recent years.

In the last year, there were nine less establishments in the glass industry, 108, compared to 117 in the previous year. However, the number of employees increased to 7,870 from 7,526 and their salaries and wages advanced to $26,291,404 from $24,698,809. The cost of fuel and electricity at works dropped to $4,173,712 from $4,315,580 but the cost at plants of materials used reached $31,000,677 from $26,606,278, with the value added by manufacture rising to $45,139,201 from $38,043,507.

Factory shipments included the following, figures in brackets being for the preceding year: cut and bevelled glass division: mirrors: plate glass, $3,356,935 ($2,870,779); sheet glass, $1,036,297 ($933,523). Other products of glass: bevelled or polished edge plate, $1,096,347 ($1,018,538); bevelled or polished edge sheet glass, $540,141 ($385,303); leaded glass, including memorial windows, $200,842 ($199,229); cut glass (tumblers, bowls, etc.) $1,124,356 ($1,047,687); decorated glassware (including engraved, etched, sand-blasted, applied color, etc.) $538,743 ($283,040); druggists', physicians' and laboratory glassware, $583,075 ($576,312); other glass products, $25,768,803 ($16,213,077); receipts for custom and repair work, $376,371 ($288,778); all other products, $1,062,856 ($1,886,572); total, $35,684,766 ($25,702,838); Pressed, Blown and Drawn Glass Division: Pressed, blown and drawn glass (including bottles, sealers, ovenware, window glass, etc.) $45,145,856 ($42,285,363); Grand total, $80,830,622.

L. O. F. NAMES D. W. DUNIPACE DIRECTOR OF DEVELOPMENT



D. W. Dunipace

Donald W. Dunipace, a career technologist with Libbey-Owens-Ford Glass Company and for the last few years chief physicist, has been named director of development, effective June 15, it was announced recently by C. W. Davis, executive vice president — production, and H. M. Alexander, general manager of research and development.

Mr. Dunipace will succeed I. G. (Tige) Fowler who is retiring after 34 years' service with the company.

Mr. Dunipace is a member of the Optical Society of America, American Physical Society, American Ceramic Society, and the American Association for the Advancement of Science.

Mr. Fowler and his wife are building a new home at 4100 Narvarez Way, St. Petersburg, Fla., and will move there upon retirement. He is a graduate in civil engineering from the University of Michigan who joined the Edward Ford Plate Glass Co., in 1923.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during March, 1957 was as follows: *Flat Glass*: A preliminary figure of 29,000 for March, 1957 indicates a decrease of 3.3 per cent from the adjusted 30,000 reported for February, 1957. *Glass and Glassware, Pressed and Blown*: An increase of 1.5 per cent is shown by the preliminary figure of 81,700 for March, 1957, when compared with the adjusted figure of 80,500 for February, 1957. *Glass Products Made of Purchased Glass*: The preliminary figure of 15,300 for March, 1957 is the same as the previous month's adjusted figure.

Payrolls in the glass industry during March, 1957 were as follows: *Flat Glass*: A decrease of 4.9 per cent is shown in the preliminary $14,147,721.63 when compared with February, 1957's adjusted $14,882,555.10. *Glass and Glassware, Pressed and Blown*: An increase of 1.8 per cent is shown in the preliminary $29,024,967.14 reported for March, 1957 when compared with the previous month's adjusted $28,525,395.57 figure. *Glass Products Made of Purchased Glass*: A preliminary figure of $4,693,678.92 was reported for March, 1957. This is an increase of 2.2 per cent when compared with the adjusted figure of $4,594,236.57 for the previous month.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

	April, 1957
Narrow Neck Containers	
Food	1,091,000
Medicinal and Health Supplies	1,340,000
Chemical, Household and Industrial	880,000
Toiletries and Cosmetics	814,000
Beverage, Returnable	839,000
Beverage, Non-returnable	122,000
Beer, Returnable	230,000
Beer, Non-returnable	681,000
Liquor	680,000
Wine	380,000
Sub-total (Narrow)	7,057,000
Wide Mouth Containers	
Food	*2,879,000
Medicinal and Health Supplies	413,000
Chemical, Household and Industrial	196,000
Toiletries and Cosmetics	243,000
Packer's Tumblers	84,000
Dairy Products	149,000
Sub-total (Wide)	3,964,000
Total Domestic	11,021,000
Export Shipments	215,000
TOTAL SHIPMENTS	11,236,000

*This figure includes Fruit Jars and Jelly Glasses.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production April, 1957	Stocks April, 1957
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics	Narrow Neck	4,350,000	6,206,000
	Wide Mouth	*3,901,000	*5,656,000
Beverage, Returnable		1,025,000	1,921,000
Beverage, Non-returnable		124,000	199,000
Beer, Returnable		321,000	581,000
Beer, Non-returnable		694,000	803,000
Liquor		675,000	1,337,000
Wine		389,000	651,000
Packers' Tumblers		82,000	120,000
Dairy Products		134,000	319,000
TOTAL		*11,695,000	*17,793,000

*This figure includes Fruit Jars and Jelly Glasses.

Glass container production: Production based on figures released by the Bureau of Census was 11,695,000 gross during April, 1957. This represents a decrease of 8.1 per cent from the previous month's production of 12,617,000 gross. During April, 1956, glass container production was 11,938,000 gross or 2.1 per cent under the April, 1957 figure. At the end of the first four months of 1957, glass container manufacturers have produced a preliminary total of 47,026,000 gross. This is 2.6 per cent over the 45,820,000 gross produced during the corresponding 1956 period.

Shipments of glass containers during April, 1957 were 11,236,000 gross, or a decrease of 1.1 per cent from March, 1957 shipments which were 11,358,000 gross. Shipments during April, 1956 were 10,839,000 gross or 4.8 per cent under April, 1957. At the end of the first four months of 1957 shipments have reached a total of 32,805,000 gross, which is 24.8 per cent under the 42,995,000 gross shipped during the corresponding period last year.

Stocks on hand at the end of April, 1957 were 17,793,000 gross. This is 2.7 per cent above the 17,318,000 gross on hand at the end of March, 1957 and 14.4 per cent higher than the 15,549,000 gross on hand at the end of April, 1956.

Automatic tumbler production: During March, 1957 this production was 5,526,000 dozen. This is a gain of 7.6 per cent against the March, 1956 production which was 5,136,000 dozen.

Shipments during March, 1957, rose to 5,520,000 dozen. This is 7.9 per cent higher than the 5,114,000 dozen shiped during March, 1956. At the end of the twelve months period ending March 31, 1957, shipments have reached a total of 55,388,000 dozen which is 10 per cent lower than the 61,544,000 dozen shipped last year.

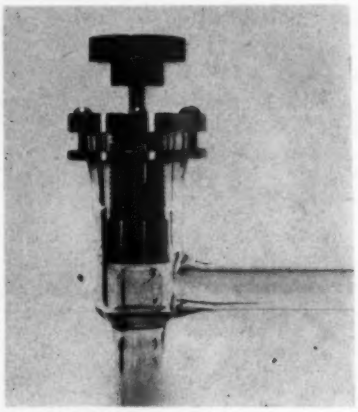
Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware during March, 1957 reached 3,488,000 dozen. This is 1.2 per cent under the 3,530,000 gross of March, 1956. At the end of the twelve months period ending March 31, 1957, manufacturers had sold a total of 33,911,000 dozen, which was 8.6 per cent lower than

(*Continued on page* 343)

New Equipment and Supplies

GLASS-METAL VACUUM VALVE

Robert C. Ewald Company, 67-52 79th Street, Middle Village 79, N.Y., offers a new glass-metal vacuum valve, claimed to meet the need for an improved trouble free stopcock. It seals to Pyrex brand glass systems and requires no mounting brackets. Contamination from excess vacuum grease



is eliminated and the condition of the moving parts and cleanliness of the valve is clearly visible. It can be outgassed by spark coiling. Metal and glass assemblies are interchangable. The valve comes with neoprene gaskets; other low vapor pressure materials are available.

NEW LIQUID DETERGENT FOR STEAM CLEANING

Oakite Products, Inc., 157 Rector Street, New York 6, N.Y., has prepared Oakite LSD, a liquid detergent designed for use in solution lifting steam guns and self generating steam cleaning equipment. Developed to simplify the preparation of steam cleaning solution and to reduce the clogging of coils in self generating equipment, it will handle a wide variety of steam cleaning operations ranging from light to medium-heavy duty. Oakite LSD is said to provide effective soil removal at concentrations of 1 to 2 ounces to each gallon of water as delivered by the gun. Used as recommended it is claimed to be safe on steel, brass, and magnesium, and to have no effect on painted surfaces. Its solutions have a pH of 12 in the operating range. Reports from users indicate that its use produces no offensive fumes.

HIGH SPEED CUTTING FOR GLASS TUBING

Kahle Engineering Company, 1400 Seventh Street, North Bergen, N.J., has announced a new horizontal type automatic high-speed glass tubing cutting machine to cut predetermined lengths of glass tubing. The machines are said to be primarily useful where high production is required on a specific diameter. Typical of the line of machinery is Model No. 1507 which can be used to cut glass tubing from which the bead and body of a diode are formed. The cutter features a continuous 30-head drive, variable speeds on both head and turret drives and high speed production of 7,000 to 15,000 units per hour.

FOUR RAMMING MIXES

J. H. France Refractories Company, Snoe Shoe, Pa., has recently developed additional "MRM" ramming mixes to meet specialized needs. Higher temperature requirements and exacting engineering applications, according to the company, brought about these variations. In addition to MRM-8, the standard product, MRM-4, -22, and -36 are available, each with different characteristics for special applications. They range in PCE from 36 to 38, in fushion point from 3290 to 3335, and in pounds per cubic foot (installed) from 140 to 170. Both dry and plastic, with air-setting and heat-setting characteristics are represented in the range of uses.

NON-FLAMMABLE MOLD LUBRICANT

Bel-Ray Company, Inc., Dept. 101, Green Village Road, Madison, N.J., has developed a non-flammable, non-carbonizing mold lubricant containing micronized flake graphite. The consistency is medium-heavy liquid which will not burn or smoke, according to the company. When applied to a surface it leaves a tenacious film of graphite. It can be washed off with water if necessary. The graphite remains dispersed indefinitely. Called GW-7X, the lubricant may be applied with either spray gun or brush. It is recommended for use in die casting, mold coating, drawing and forming lubricants and die forging.

NEW MAGNETIC SEPARATOR

Carpco Manufacturing, Inc., Jacksonville, Fla., announces their Model M12 high intensity induced roll electromagnetic separator. The unit has been expressly designed for laboratory work and may be used for production control and development; it is said to give long and trouble free service. Feed rates as high as two pounds per minute, depending on the character of the material being separated. The separator is of drain-clean construction so that very small samples can be run without loss of material. It is designed to operate on 110-115 volts DC, but for versatility is furnished with built-in silicon rectifiers; this feature allows the separator to be used anywhere on 110-115 volts AC. A transformer may also be incorporated to operate on 220-230 volts, 50/60 cycle AC.

An especially designed potentiometer and circuit allows a continuously variable control of the magnetic flux from zero to full saturation of the magnetic components. The rotor is driven by a direct current, flex-mounted, one-quarter horsepower TEFC motor. Rotor speed is continuously variable from 50 to 340 RPM. The rotor has enclosed self-lubricated ball bearings. The nose pieces are milled in such a way as to vary the magnetic gap by moving the nose piece horizontally.

CATALOGS RECEIVED

Selas Corporation of America, Dresher, Pa., has issued a 24-page bulletin, S-1053, "An Approach to Interpretive Research", which describes the laboratory facilities at Selas available for contract research to private companies, trade organizations, government agencies and other organizations. The brochure may be obtained free of charge.

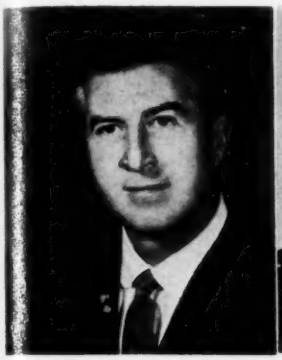
Paisley Products, Inc., 630 West 51st Street, New York, N.Y., has available a new reference file for shippers of packaged goods in the glassware and other industries which use shipping containers. The file concerns Paisley's sprayable non-slip container coating No. 1715. The coating permits the stacking of smooth-top containers for plant handling or road shipment without danger of toppling from pallet, conveyor or truck. The file contains a new revision of the Paisley Laboratory Report on the product containing technical facts on the characteristics and use of the product. The file also offers an inventory of equipment suitable for automatically applying the invisible coating to containers or container blanks with existing production, packaging or conveyor lines.

Union Carbide and Carbon Corporation, Silicones Division, 30 East 42nd Street, New York 17, N.Y., has issued two new data sheets: One sheet describes Union Carbide LE-45 silicone spray lubricant, an emulsion of silicone oil in water; the other sheet describes LE-451, an oil-in-water emulsion containing suspended graphite.

AMERICAN POTASH ESTABLISHES SECTION AS COORDINATING UNIT

American Potash & Chemical Corporation has established a technical sales services section to act as coordinating unit among the company's Production, Market Development and Sales departments.

Announcement of the technical services section was made by W. J. F. Francis, AP&CC vice president in charge of sales, who said the newly formed section would be a part of the Sales Department but would provide liaison on technical matters to the various departments.



D. A. Lundy

N. E. Wendt

Daniel A. Lundy, formerly western sales supervisor of boron and lithium products, will be western manager of the new section, while Nelson E. Wendt, previously head of northeastern sales, will be eastern manager. Lundy and Wendt will operate from the company's Los Angeles and New York offices respectively.

"The technical services section was formed as a result of the company's 400 per cent increase in sales during the past 10 years," Francis said. "Because of the rapid growth, it became necessary to set up a coordinating unit to handle technical information on product properties, uses, packaging and applications not only to the various AP&CC divisions but also to customer companies."

A key function of the section will be in connection with the transfer of new products from AP&CC's Market Development Department to the Sales Department.

H. D. PRIOR APPOINTED TECHNICAL DIRECTOR

Harold D. Prior has been appointed technical director of The Chas. Taylor's Sons Company, a subsidiary of National Lead Company. His headquarters will be in Cincinnati.

Mr. Prior has been manager of National Lead Company's Washington, D. C., office since July 1955. He was graduated from Alfred University in 1936, and was first employed as a ceramic engineer by the company in the Niagara Falls laboratories of its Titanium Alloy Manufacturing Division the same year.

A COMPLETE REFRACTORIES SERVICE ...

for the

Glass Industry

Brick are important to the glass industry which supplies all of us with a multitude of everyday necessities.

RITEX basic brick, for regenerator chambers and checkers, make a four year campaign more than a wistful dream. Unaffected by batch carry-over and condensed soda, RITEX magnesite checker brick retain their full size and original regenerator efficiency month after month. RITEX CHROME brick, for the regenerator crowns and walls, have low conductivity which can be translated into fuel savings. They can be insulated without seriously affecting their service life because they do not melt or slag at the operating temperatures encountered.

Grefco fire clay brick are recommended for the lower portions of the checker settings, the lower regenerator walls, the rider tile and for lining the flues.

Grefco silica brick, for caps and breast walls, are uniform and of highest quality, and are available in standard or super duty grade.

You will find one or more Grefco plants ready to supply each major glass producing district at minimum transportation costs.

GENERAL REFRACTORIES CO.
Philadelphia 2, Pa.

GENERAL REFRACTORIES

Fuel Savings . . .

(*Continued from page* 327)

at the metal line had 7 inches of block remaining at the top 18 inch course and 11 inches of block remaining on the lower 24 inch course. A large flux block was interposed in the lower course of the 11 inch fused cast material and a small flux block on top in the 7 inches remaining in the upper 18 inch course. The flux blocks were over hung 3 inches similar to overcoat blocks. The bottom flux blocks of this surface were not paved and failed after the 32 months operation.

Fig. 2 shows the construction used in the side wall of our #1 furnace. Furnace bottom 12 inch flux blocks were paved with 4 inch fused cast blocks; the glass face side of the 24 inch lower course has 6 inch x 24 inch fused cast blocks backed up with a 10 inch thick x 24 inch flux block with a 3 inch overhang; the glass face side of upper 14 inch thick x 18 inch x 9 inch L shaped fused cast block with one inch overhang on glass face side to protect the horizontal joint, has a 9 inch x 8 inch flux built in back setting on top of the 10 inch x 24 inch flux block so that a 9 inch solid fused cast section is left for metal line erosion.

Fig. 3 illustrates the construction used on the melting zone bridge wall. A 6 inch x 30 inch fused cast block on the glass face side is backed up with an 8 inch by 30 inch flux block on lower course and a 14 inch x 12 inch solid fused cast block on the top course. This block construction protrudes 2 inches in the melting section of the furnace.

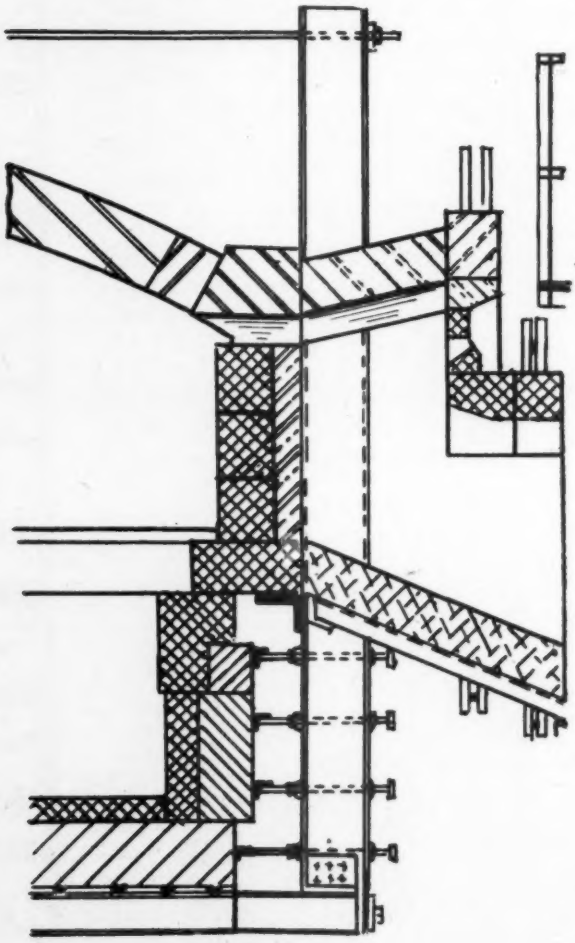


Fig. 6

Fig. 4 diagrams the construction used on the refining or nose section of the bridge wall. A 6 inch x 20 inch fused cast block on the glass face side backed up with an 8 inch x 20 inch flux block on lower course and a 14 inch x 10 inch solid fused cast block on the top course. This block section also protrudes 2 inches in the nose section of the furnace.

Fig. 5 shows the construction used at the back wall, triangular dog-house section. A 6 inch x 24 inch fused cast block on the glass face side is backed up with a 6 inch x 24 inch flux block on the lower course and the 18 inch solid fused cast special shape blocks, upper course, are used for constructing a triangular dog-house.

Fig. 6 Cross cut section showing the side wall block construction, paved bottom and 5 inches of fire brick in back of 10 inch fused cast solid breast wall blocks.

This side wall, bridge wall and back wall block construction were built in our small #1 furnace which has a 208 sq. ft. melting chamber 17 feet 4 inches x 12 feet wide, 3 side ports. The checker volume is only three-and-a-half times larger than the square feet melting area which is constructed on a 6 inch x 6 inch basic super duty fire brick semi-basket weave setting. Maximum combustion gas temperature above top of checker in #1 port neck equals 2358°F. Temperature of top checker equals 2350°F. Maximum temperature of preheated air equals 2200°F. Temperature at end of 15 minute cycle equals 1957°F. There is a temperature differential of 243°F of preheated air for the checker. The fuel saving using this side wall block arrangement with the 4 inch paving blocks on 12 inches of flux bottom and the balanced construction used in the upper structures is 25 to 30 gallons of heavy bunker C oil per hour, approximately 15 gallons less per ton of glass or 18 per cent of the total input of fuel. This furnace has been in operation only eight-and-a-half months to date but we expect to get the same operational life as would be obtained with an all 12 inch solid fused cast block construction.

In conclusion, the fuel savings, whether with natural gas or fuel oil, depends on the refractory balance in every section of the furnace, with its proper design and type of checker and with whatever means used to control the ambient temperature about the furnace, so that the idle-load fuel requirements are kept very low in the beginning of its operation.

AMERICAN LITHIUM INSTITUTE EXPANDS

The American Lithium Institute, Inc., has moved to new and larger quarters on the fourth floor of 32 Nassau Street, Princeton, N. J.

A non-profit corporation, the Institute was recently formed to broaden the present markets for lithium and its compounds and develop new markets through the sponsorship of research and the dissemination of information.

Mail for the Institute should be addressed to P. O. Box 549, Princeton, New Jersey.

Current Statistics . . .
(*Continued from page* 339)

the 37,097,000 dozen sold during the corresponding period last year.

• • •

The following material has just been released by the U.S. Department of Commerce, Bureau of the Census, on pressed and blown glassware in 1956:

Factory shipments of pressed and blown glassware (except glass containers) amounted to $391.0 million during 1956, a 3 per cent increase over 1955 shipments of $378.3 million. Shipments of lighting glassware in 1956 totaled $156.7 million, a slight decrease from the $158.8 million shipped in 1955. Machine-made tables, kitchen, art, and novelty glassware shipments decreased 3 per cent, from $87.0 million in 1955 to $84.4 million in 1956, while hand-made table, art, and novelty glassware shipments increased 13 per cent, from $26.9 million in 1955 to $30.3 million in 1956. Shipments of glass cooking ware totaled $19.9 million in 1956, 7 per cent higher than 1955 shipments of $18.6 million.

The 1956 data in this release are based on reports collected on Census Form MA32E, "Pressed and Blown Glassware (Except Glass Containers)," and include all known manufacturers of these products. This report covers only products manufactured from glass produced in the reporting establishment. The figures represent physical shipments from the reporting establishments, including products shipped or consignment, and do not represent sales of glassware to the ultimate consumer. The dollar value of shipments is based on the manufacturer's selling price, f.o.b. plant, after discounts and allowances and exclude freight charges and excise taxes.

Pressed and Blown Glassware (except glass containers):
Value of Shipments by Class of Products, 1956-1952

Class of product	Value ($1,000)				
	1956	1955*	1954	1953	1952
TOTAL	390,975	378,279	379,754	361,865	324,599
Machine-made table, kitchen, art, and novelty glassware	84,378	86,983	83,584	81,951	78,681
Hand-made table, art, and novelty glassware	30,326	26,939	26,460	30,335	30,113
Cooking ware (heat-resistant, heat-treated, and annealed)	19,852	18,640	13,434	14,807	14,920
Lighting glassware	156,693	158,793	156,893	146,549	115,831
All other pressed and blown glassware (except glass containers)	99,726	86,924	99,383	88,223	85,054

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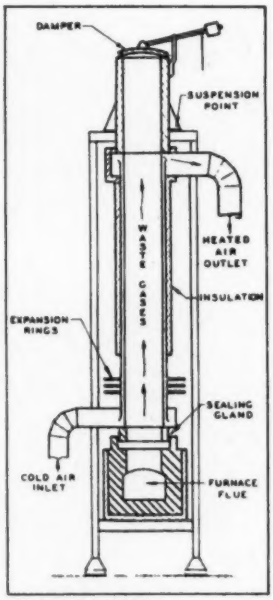

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Miniature Portraits . . .
(*Continued from page* 330)

Gellatly Collection was purchased by John Gellatly from Pauly & Company some time prior to 1921.

All the recognizable subjects, with the exception of Columbus, have played major roles in Italian history during the period of consolidation (1848-1860), when the various principalities and states comprising the Roman Peninsula were brought together under Victor Emanuel II.

Count Camillo Benso di Cavour (1810-1861): The great constructive statesman of modern Italy who was a pronounced advocate of a free and united Italy. (Fig. 2)

Alfonso LaMarmoro (1804-1878). A much decorated general in the wars of 1848 and 1859 against Austria. (Fig. 2)

Fig. 8. Scent bottle showing portrait murrini of Pope Pius IX, Ferdinand I of Austria, Francis Joseph I of Austria. (Portraits have been outlined with white ink.) ***Author's Collection.***

Victor Emanuel II. King of Sardinia from 1849 to 1861, and of Italy from 1861 to 1878. (Fig. 2)

Ferdinand I. Emperor of Austria from 1835 to 1848. Because of his age and weakness the various provinces of Italy began to fall away from his grasp to join the nationalistic movement towards a united Italy under Victor Emanuel II. (Fig. 8)

Francis Joseph I. Emperor of Austria of 1848 to 1916. Ferdinand I was forced to abdicate in favor of his nephew Francis Joseph, whose youth and popularity it was believed would make it easier to harmonize the conflicting interests of the monarchy, especially in Italy. (Fig. 8)

Pope Pius IX, 1846 to 1878, was perhaps the most memorable pope of this name, alike because of his long pontificate and early liberalism in politics (until checked by Mazzini's attempt to establish a republic in Rome, in 1849). (Fig. 8)

EARL MILLARD JOINS OBEAR-NESTER GLASS COMPANY

Earl Millard has been appointed assistant to the president of Obear-Nester Glass Company, headquarters of which are in East St. Louis, Illinois, according to an announcement made by Maxwell J. Jones, president, at a recent meeting of the Company's board of directors.

Mr. Millard resigned his position as president of the American Partition Company, a division of Standard Brands Incorporated, after having held that position for the past nine years, to accept the new post. Previous to that time he had been vice president and director of Clinton Foods, Inc.

Mr. Millard is a director of the First National Bank of East St. Louis, and a director of the State Savings and Loan Company in East St. Louis. He is a past president of the East St. Louis Chamber of Commerce. He is a graduate of Washington University in St. Louis, Missouri, where he lettered in football and track.

Mr. Millard is married to the former Dorothy Nester, a daughter of Mr. and Mrs. Joseph K. Nester. Mr. Nester is chairman of the board of directors of Obear-Nester Glass Company.

HIGH-MELTING FIBERS LICENSE

Doctor Alexander Silverman, Professor of Chemistry in the University of Pittsburgh and Consultant on Glass, announces that he has licensed Houze Glass Corporation of Point Marion, Pa. to manufacture high-melting glass fibers under his American and foreign patents. These include:

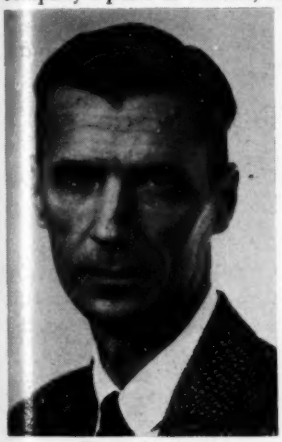
Belgium No. 517,253. Method of Making Glass, issued July 29, 1953; French Patent No. 1,074,044. Method of Making Glass, issued March 31, 1954; Italian Patent 497,964. Method of Making Glass, issued January 17, 1955; British Patent No. 725,656. Improvements in/or Relating to Method of Forming Glass Shapes and Resulting Products, issued June 29, 1955; U. S. Patent No. 2,736,141. Method of Producing Glass Filaments, issued February 28, 1956. Also included are patents pending in Canada, Germany, and the United States.

CORNING MAKES REFRACTORIES CHANGES

William F. Kiefer has been named manager of the Corning Glass Works Refractories Plant, it was announced recently by Edward C. Leibig, general manager of the Refractories Division.

He replaces Donald W. Shoemaker, who will become manager of manufacturing at Corhart Refractories Company, Inc. of Louisville, Kentucky. Corhart is a subsidiary of Corning Glass Works.

Named to Mr. Kiefer's former post as production superintendent of "A" Factory is Robert A. Sanders, who has been assistant to the production manager at the company's plant at Albion, Michigan.



W. F. Kiefer

A native of Charleroi, Pa., Mr. Kiefer is a graduate of California State Teachers College. He joined Corning Glass Works in 1940 and served as a laboratory technician and process engineer at the Charleroi Plant before entering the army.

Since the war, he has served at Charleroi and Corning as lighting engineer, lighting salesman, instrument engineer, department foreman and general foreman. He became production superintendent of the company's optical plant in 1952 and moved to the same post at the Harrodsburg (Kentucky) Plant in 1954. Mr. Kiefer became production superintendent of "A" Factory in 1956.

H. K. PORTER CREATES NEW POSTS IN REFRACTORIES DIVISION

Edgar G. Platt has been appointed to the newly created post of general works manager, Refractories Division, H. K. Porter Company, Inc. He will supervise the operation of Porter's Refractory Division's nineteen plants which produce Laclede-Christy refractories, McLain Fire Brick, and Mullite refractories. Mr. Platt was works manager for Porter's McLain Fire Brick Division, and was with McLain since 1923.

E. M. Richardson has been appointed general sales manager of Porter's Refractories Division. He will direct the coordination of the Refractory Division's sales of Laclede-Christy, McLain and Mullite. Mr. Richardson has been a management consultant in Philadelphia.

J. H. SEPHTON, PLANT MANAGER FOR DOMINION GLASS, RETIRES

T. W. Bassett, president of Dominion Glass Company Ltd., has announced the retirement of James H. Sephton, manager of the Montreal plant, after 53 years of service with the company. He had been manager of the Montreal plant since 1946, and plant manager at Hamilton, Ont. for 19 years before his last assignment.

Mr. Bassett also revealed the appointment of Leo Dubeau as acting manager of the Point St. Charles factory and Norman Varley as acting superintendent.

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The Glass Division . . .
(*Continued from page* 324)

Mr. Westman, was a continuation of a study of phosphate glasses and is an attempt to apply polymer chemistry to reveal the structure of certain phosphate glasses.

The chain length distributions in solution of sodium phosphate glasses were reinvestigated using improved paper chromatographic techniques. The range of composition was extended to glasses of higher Na/P ratios by using a through-flame technique for their preparation. The distributions obtained confirmed the earlier work with the exception that cyclic phosphates were found in solutions of glasses having or approaching the metaphosphate composition despite prolonged heating of the glasses in the molten condition. The earlier observation was that prolonged heating eliminated the cyclic phosphates. As before, no orthophosphate was found, as predicted by Van Wazer, and neither the Poisson nor the Random Reorganization distributors fitted the data for both low and high average chain lengths. Although some sort of rearrangement occurred in the melt, it may not be a completely random process; a rapid change of chemical properties with chain length of the short polymers may have to be taken into account. This was confirmed by similar studies of potassium and lithium phosphate glasses, whose distributions were found to be sufficiently different to demonstrate a cation effect. Consequently, more than stoichiometry is involved.

The next paper, "Glass Formation and Properties of Glasses in the System Na_2O-B_2O_3-SiO_2-TiO_2," was written by J. H. Strimple, National Lead Company, South Amboy, New Jersey and E. A. Giess, State University of New York, College of Ceramics, Alfred University, Alfred, New York.

This paper was primarily concerned with the role of TiO_2 in the system Na_2O-B_2O_3-SiO_2-TiO_2. Glasses containing up to 45 mole percent TiO_2 may be formed with an alkali content of 30 mole percent. At lower alkali contents (10 mole percent Na_2O) glasses may be formed containing up to 22 mole percent TiO_2. The linear coefficient of expansion, transformation and softening temperatures were decreased by TiO_2 additions. The melting temperature of the raw glass batch and high temperature viscosity were also reduced by adding TiO_2.

The density and refractive index were increased with increase in TiO_2 content. The durability was believed also to improve with increase in TiO_2.

The next paper, "A Study of the Surface Durability of Container Glasses," was presented by H. E. Simpson, State University of New York, College of Ceramics, Alfred University, Alfred, New York.

Cyclic-humidity tests were made on glass containers in order to ascertian what influence "finish" or constriction of the opening at the mouth of the bottle may have on the surface durability. It was found that the smaller the opening of the container, the greater the deterioration of the interior surface.

A study by means of electron micrographs indicated that the outside surface was scratched showing the effect of mold marks and other inhomogeneties. The inside surface appeared to be more pitted and open suggesting a reason for the decreased durability. Examples of surfaces showing good and poor durability were pictured. The study, when augmented by electron microscopy, promises to be an aid to the study of the surface chemistry of glass.

The next paper, "Inhibition of Alkaline Attack on Soda-Lime Glass," was written by George A. Hudson, Mobay Chemical Company, New Martinsville, W. Virginia, and Frank R. Bacon, Owens-Illinois, and was presented by Mr. Bacon. A variety of materials—particularly compounds of beryllium, zinc, and aluminum—have been reported to inhibit the action of sodium hydroxide solutions on glass bottles.

The action of 3 percent NaOH solutions containing 2 or 10 milligram-atoms of "modifier" per kilogram of solution were studied. The glasses had the following composition:

	Calcite	*Dolomite*
SiO_2	71.6	70.5
R_2O_3	1.9	1.6
CaO	12.2	8.3
MgO	0.2	5.6
BaO	0.0	0.7
Na_2O	12.7	12.7
K_2O	0.8	0.3

Exposures were made for four weeks at 125°F. The loss in weight after the exposure was taken as a measure of the inhibiting action of the solution. Among the elements tested, beryllium and zinc compounds were most effective. Strontium, antimony, barium, aluminum, and lead were next. Bismuth, tin (stannous), zirconium, and copper showed a small inhibiting effect. Magnesium, silicon, and tin (stannic) showed none.

The next paper was "Detection of Reaction Products Between Water and Soda-Lime-Silica Glass," by Franklin Fu-Yen Wang, Glascote Products, Inc., Cleveland, Ohio, and F. V. Tooley, University of Illinois, Urbana, Illinois. The paper was presented by Mr. Wang.

A unique approach to the study of the attack of glasses by water was made. The identities of the reaction products were detected through a simulated extract approach. A solution was simulated to contain the same composition as the glass extract, and to give the same rate of reaction as that of the glass extract. The constiution of the simulated extract was considered to be identical to that of the glass extract. Through this approach, the reaction products between water and soda-lime-silica glass were found to be sodium metasilicate, calcium metasilicate, and metasilicic acid.

The last paper of the Tuesday afternoon session, "Influence of Reaction Products on Reaction Between Water and Soda-Lime-Silica Glass," was also written by Mr. Wang and Professor Tooley.

Mr. Wang continued a description of his work on the study of the attack of soda-lime-glass by water. The reaction products from water and a soda-lime-silica glass were found to be sodium metasilicate, calcium metasilicate, and metasilicic acid. Each reaction product was used to react with the glass separately. The kinetic studies of these reactions suggested a plausible mechanism of the reaction between water and the glass. Tooley's conception of excess cation ratio was employed to afford a structural interpretation of results. Rate-controlling processes in the reaction were found to be the diffusion of sodium ions, and the extraction of silicates through the breakdown of the glass network.

Wednesday morning a joint session with the Basic Science Division was held with Orson L. Anderson, Bell Telephone Laboratories, Murray Hill, New Jersey, acting as chairman.

The first paper, "The Diffusion of Argon in Potassium-Lime-Silica Glass," was presented by M. B. Reynolds, General Electric Knolls Atomic Power Laboratory, Schenectady, New York.

Diffusion coefficients for bulk diffusion of radio active argon ($_{18}A^{39}$) with 260 years half life emitting .57 Mev (million-electron-volts) beta particles, in a potassium-lime-silica glass were determined at temperatures ranging from 308 to 470° C by a radioactive counting technique. The sensitivity of the measurements were said to be about 100 fold greater than previous ones. The glass had the following composition:

SiO_2	62 percent
K_2O	26
CaO	5
Al_2O_3	5
Balance	2

Argon diffusion was found to follow classical bulk diffusion theory within the limits of experimental accuracy. The diffusion equation was as follows:

$$D = D_o e^{-Q/RT}$$
$$Q = 42 \text{ K cal/mol}$$
$$D_o = 360 \text{ cm}^2/\text{sec.}$$

The activation energy and diffusion coefficients obtained were compared with values obtained for helium and argon by other workers who used the permeation technique. The mechanism of permeation was described as (1) gas dissolved at first surface, (2) then diffuses through body of the glass and then (3) comes out of solution at second surface. The only apparent change in the glass due to the radiation was a slight color change. There was no evidence of spalling devitrification, fracturing, or other deterioration. This paper was of specific interest to manufacturers of gas-filled rectifiers as well as to nuclear engineers who have a definite interest in fission-gas problems.

The next paper, "Gaseous Diffusion Under Stress In Glass and Alumina," was presented by K. D. McAffee, Bell Telephone Laboratories, Murray Hill, New Jersey. The penetration of helium gas through Pyrex glass was described by means of an extremely complicated ionization-manometer technique. For the glass under study the helium diffusion was observed to be about 10 times greater under tension than with no stress, but only slightly greater under compressive stress.

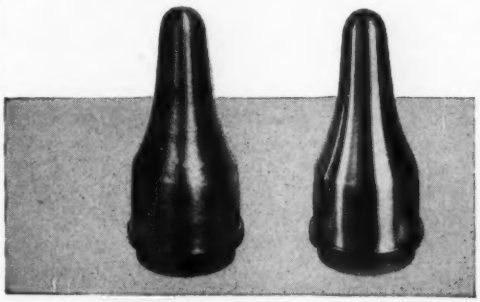
Helium cannot penetrate through the hole or ring position with crystalline silica, but it can penetrate to some degree through the distorted random net work of Pyrex glass. To permit this diffusion, the openings must be about the approximate size of the helium atom. Other gases such as water were tried with little evidence of diffusion.

Experiments have shown that the low diffusion constant of gases in some high alumina ceramics as compared with glass results in superior properties for their use under vacuum conditions and under extreme pressures. At 750° C. helium shows some permeability through alumina

(*Continued on page 348*)

THERMOSPRAY coated mold plungers give 8 times longer service life

Important savings are being made in production down-time and replacement-part costs on equipment subject to heat and abrasion. Typical of these are mold plungers like those shown here which are being THERMOSPRAY coated by glass manufacturers for protection against heat corrosion. Other advantages include improved product quality, with better finish on glass parts. Longer production runs are feasible without dismantling machines.



Before (left) and after (right) coating with METCO *ThermoSpray* Process. Users report coated plungers last average of 8 times longer than uncoated. Parts finish is improved, production down-time reduced.

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The Glass Division . . .
(*Continued from page* 347)

but at 450° C. has an advantage over glass of about a million fold. Because of the high permeability of glass by helium, glass may be considered as an atomic sieve.

The next paper, "Studies on Wettability of Platinum by Molten Sodium Silicate," was written by M. L. Volpe, R. M. Fulrath, and J. A. Pask, University of California, Berkeley, California. This work represents a continuation of fundamental studies that have been underway at the University of California for some time. The research which involves a study of contact angles and the wetting of various metals by molten silicates, is of definite interest in such problems as glass-to-metal seals, vitreous enamelling, and other glass working involving metals.

Most of the experiments were performed at temperatures of 850°-1000° C. with $Na_2O{\cdot}2SiO_2$ upon platinum; some work was also done on $Na_2O{\cdot}2SiO_2$ gold. For the most part, air, and chemically pure oxygen and nitrogen (at pressures ranging from a few microns to an atmosphere) were the gases employed, but argon and water vapor were also used.

The effect of various atmospheres on the contact angle of $Na_2O{\cdot}2SiO_2$ glass on platinum were as follows (low to higher angle): O_2, N_2, CO_2, A (argon), water vapor, CO and H. Attempts to explain these results were based on theories of a definite penetration of gases at the surface of the metal.

Sorption of the gases at low pressures by the metals was determined both in the absence and presence of glass. Contact angle measurements were simultaneously made when feasible. Temperatures in these experiments ranged from 750°-1000° C. The results were used to provide a mechanism for the change in contact angle with pressure which was observed with some gases.

The next paper, "Activities in Borosilicate Melts: II, Some Mixtures of Calcium Borates—Calcium Silicates," was written by W. J. Knapp, University of California, Los Angeles, California, and H. Flood, Institute of Silicate Science, Norwegian Institute of Technology, Trondheim, Norway. The paper was presented by Mr. Knapp.

Simple expressions of activities, as functions of composition, were developed from structural models for some borosilicate melts. Ther applicability was tested with data from the liquidus curves of phase diagrams. If the heat of fusion is known, a value of the activity-compositions function can be calculated for each temperature of the liquidus curve. These values were compared with activities computed from the structural model. Calorimetric heats of fusion were available for the calcium borates studies: Experimental data from published phase diagrams for the systems $Ca_3(BO_3)_2$-Ca_2SiO_4, $Ca_2B_2O_5$-Ca_2SiO_4, $Ca_3(BO_3)_2$-$CaSiO_3$, $Ca_2B_2O_5$-$CaSiO_3$, $CaSiO_3$-$BaSiO_3$ and $CaSiO_3$-K_2SiO_3 were used.

The models produced favored a structure that showed well mixed chains and rings. Simple ionic models seemed applicable in most cases, excepting for melts of highly polymerized mixed-ions (metaborate-metasilicate), for which the so-called "group" model appeared useful. The value for the heat of fusion of $CaSiO_3$ was calculated from the data collected and found to be 13,200 cal/mole which checked very well with the work of Kelly and others in the field.

The next paper, "Structural Interpretation of Immiscibility in Oxide Systems III: Effect of Alkalies and Alumina in Ternary Systems," was written by Ernest M. Levin and Stanley Block, National Bureau of Standards, Washington, D. C. This paper, which was presented by Mr. Levin, was a continuation of recent work carried out by the National Bureau of Standards on structural aspects of immiscibility in oxide systems. It was proposed that homogenizers such as Na_2O, K_2O, Al_2O_3 tended to coordinate otherwise incompatible structures.

Two methods of a semi-independent type were explained to show the effect of such homogenizing in ternary silicate and borate systems. Both methods yielded results that are quite comparable.

Observed and calculated values were presented for the amount of homogenizer required in ternary borate systems and coordination figurations were shown to illustrate the dominant role of the homogenizer in both silicate and borate systems.

• • •

Report of the Research Committee of the American Ceramic Society on the Survey of the Glassy Phase in Ceramics. L. Navias, General Electric Research Laboratory, Schenectady, New York.

Mr. Navias pointed out that the principal objective of the research committee was to find a problem that that was of mutual interest and importance to the various divisions of the Society. The general subject of the glassy phase or vitreous state was of broad interest and had proven to be of extreme value. The various divisions had shown interest in the subject in the following manner:

Glass Division—The division has attempted to obtain extensive information on Soviet literature related to glass. The information will involve considerable translation and a survey of all translating agencies is being conducted.

Basic Science Division—has prepared an important bibliography of approximately 300 references related to the structure of glass. The work was assembled by W. G. Lawrence and is available from Alfred University at a price of 50 cents.

Enamel Division—is contemplating a general study of the corrosion of vitreous surfaces.

Refractories Division—has made an extensive survey and review of 20,000 references of which approximately 1 per cent are applicable to vitreous state as a bond between refractory grains.

Structural Clay Division—This division has made a survey of active research investigations on the general subject of the vitreous state in ceramics. It is reported that 10 universities and 3 research institutions are quite active on this subject.

Whiteware Division—A survey is being made to determine the importance of the glassy phase in such fields as electrical porcelain, earthenware, tile and various white ware bodies.

Materials and Equipment Division—This division has attempted to list instruments which are available and useful in glass investigations and pilot plant work. The desirability of coordinating the needs of the various divisions was emphasized as well as preserving some degree of continuity of work, especially because the personnel of the committee changes from year to year.

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Inventions and Inventors . . .

(*Continued from page* 336)

sleeve falls off and much of the fluid exercises very little cooling function.

An improved assembly is shown in Fig. 3. A supply of coolant such as water or compressed air is fed into the inlet tube 32 and flows upward along the electrode 20 until it reaches the bushing 18 whereupon the coolant is removed through the outlet tube 36. Since the electrode 20 is coolest at the air exposed portion and most hot in the glass furnace, the coolant exercises its cooling function according to the counter-current flow principle and does not come into contact with a thin wall which is itself in contact with the molten glass in the tank. All of the cooling effect of the coolant is thus exercised upon the electrode and bushing and none of the coolant is permitted to escape without having its temperature raised by the electrode. The small annular space between the electrode and the aperture of the bushing 18 is filled with glass which has solidified under the effect of the coolant; there is also solidification of glass on the other side of the bushing which acts as a further insulator between the extremely high temperature of the molten glass in the furnace and the temperature of the coolant on the other side of the bushing.

The electrode may be fed into the furnace by merely stopping the supply of coolant to allow the solidified glass to soften.

There were fifteen claims and the following references were cited in this patent: 858,000, Von Kugelgen, July 2, 1907; 2,389,033, Dubsky, Nov. 13, 1945; 2,419,139, Hopkins, Apr. 15, 1947; 2,509,326, Weaton et al., May 30, 1950, and 2,693,498, Penberthy, Nov. 2, 1954.

Glass Wool and Fiber

Conveying and Severing Mineral Fibers. Fig. 4. Patent No. 2,719,336. Filed August 19, 1950. Issued October 4, 1955. Three sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by R. V. Stotler.

The present invention embraces a method of conditioning continuous strands of mineral fibers such as strands of attenuated glass fibers and an improved method and means for severing them into comparatively short lengths.

In Fig. 4 the cutting or severing knives 30 project radially from the axis of the cylinder 28 and outward from the cylindrical surface of the roller so as to facilitate engagement of the knives 30 with the fibers or strands S and the yieldable surface 17 of the roll 16 to effect a severing of the fibers or strands into predetermined lengths.

One or more linear groups or strands S of fibers or filaments are directed between the rolls 16 and 25 so that upon energization of the motor 19 the roll 16 automatically advances the strands of fibers. After the strands are initially started through the rolls, they follow the peripheral contour of the roll 16 under the guiding influence of the cylindrical surface of the knife carrying roll 28 and are conveyed downward to the severing zone in which the knives 30 successively engage the moving strands of fibers to sever the same into predetermined lengths. The lengths of the cut strands of fibers are determined by the peripheral linear distances

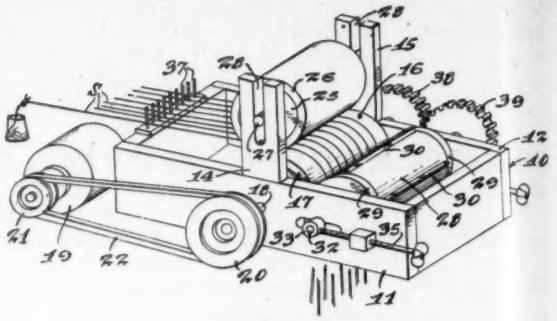

Fig. 4

between adjacent strand severing knives or bars 30. The cut strands may pass downward under the influence of gravity to be collected by any suitable means or they may be conveyed to a station remote from the severing zone by a moving air stream or other suitable motivating means.

Through this method the difficulties of the cut strands adhering together to form clumps or groups have been eliminated and a precision control of the lengths of the cut strands is established.

There were 4 claims and 12 references cited in this patent.

Sheet and Plate Glass

Plate Glass Resistance Heaters. Fig. 5. Patent No. 2,709,211. Filed May 27, 1953. Issued May 24, 1955. One sheet of drawings. Assigned to Blue Ridge Glass Corporation by Theodore W. Glynn.

This invention relates to electric resistance heaters in which electric heating elements cover one side of tempered glass plates, and more particularly to the electrical terminals for such heaters.

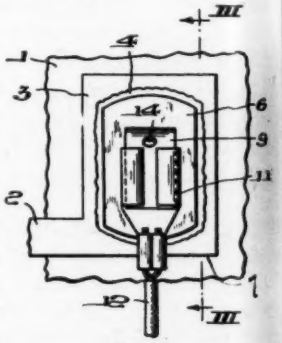

Fig. 5

Referring to Fig. 5, a rectangular panel or plate 1 of tempered glass, of the kind used for an electric resistance type of space heater, is shown. Mounted on one side of the glass plate is an electric heating element 2 which is formed from at least one electrical conductor that has its ends 3 enlarged and located close to each other. The conductor is formed from suitable electrical resistance material, generally aluminum or aluminum alloy, sprayed on the surface of the plate in a very thin strip. On the larger terminal areas 3 of the heating element an additional coating 4 or a solderable metal, such as copper or brass or zinc, has been sprayed because it is difficult to solder directly to the thin aluminum areas.

The bases 6 of a pair of metal connectors are joined to the coatings 4 by an ordinary high melting point lead-tin solder 7. The entire assembly is then heated to the melting point of the solder to make a sweat joint between the connectors and plate. With both the plate and the connectors at the same temperature at the time of fusion

(*Continued on page* 352)

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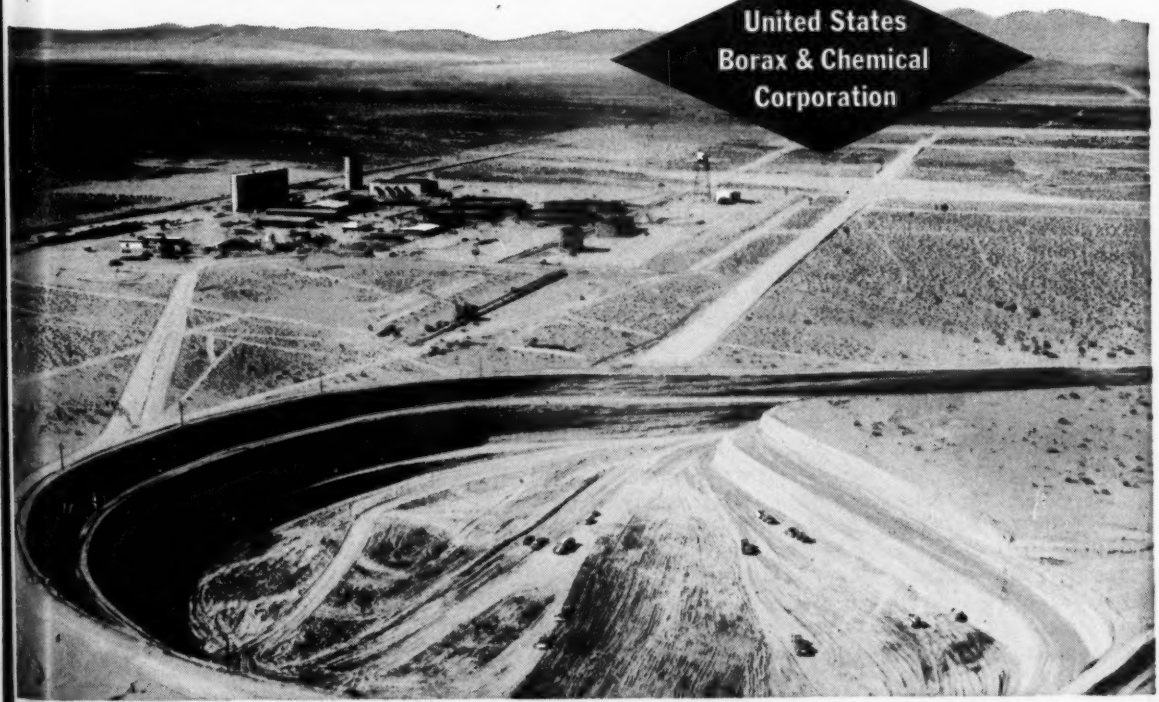

Inventions and Inventors . . .

(*Continued from page* 350)

of solder 7, and with both being cooled down together, the final joints are free from shrinkage stress and will remain that way in service.

The material of which the connectors are made is a low expansion metal having substantially the same coefficient of expansion as the glass plate. An example of a preferred metal alloy having the proper coefficient of expansion is one composed of about 48 per cent nickel and about 52 per cent iron.

There were 8 claims and 5 references cited in this patent: 1,647,474, Seymour, Nov. 1, 1927; 2,418,461, Becker et al., Apr. 8, 1947; 2,581,967, Mitchell, Jan. 8, 1952; 2,636,920, Lockery et al., Apr. 28, 1953 and 2,644,066, Glynn, June 30, 1953.

Apparatus for Making Multiple Sheet Glazing Units. Patent No. 2,761,249. Filed October 8, 1952. Issued September 4, 1956. Five pages drawings; none reproduced. Assigned to Libbey-Owens-Ford Glass Co., by Albert W. Olson and John A. Woods.

This invention relates broadly to the production of all-glass, multiple sheet glazing units.

This invention involves apparatus comprising a furnace provided with a longitudinal, continuously moving conveyor on which glass sheet supporting trays may be carried past burners at opposite sides of the furnace for sealing together the marginal edge portions of the sheets. The burners are provided with heads from which flames may be played directly along said edge portions which are softened by said flames and freely bend into fused relation with one another. The burner heads and flames emitting therefrom are mounted above stationary stands and are resiliently urged into an inwardly disposed normal position.

The burner heads are movable on a swivel mounting from the normal inwardly directed position to an operative position parallel to but spaced from said normal position. The tray upon which the glass sheets may be supported in spaced relation is constructed in such a manner as to coact with portions of the burners when moved past them to cause said burner heads to automatically move in the manner described to the operative position. The burner heads are then in properly aligned relation with respect to the marginal edge portions of the glass sheets moving past.

The tray is also constructed in such a manner as to support marginal edge portions of the upper sheet of glass in fixed relation above those of the lower by means of rotatably mounted arms. Means are attached to the burners in a position to coact with the tray arms, as the tray is moved past, in order to remove the support from the marginal edge portions of the upper sheet just prior to the sealing thereof with those of the lower sheet.

There were 14 claims and the following references cited in this patent: 892,032, Douglas, June 30, 1908; 954,241, Affelder et al., Apr. 5, 1910; 2,194,755, Kell, Mar. 26, 1940; 2,278,607, Anderson, Apr. 7, 1942 and 2,624,979, Clever et al., Jan. 13, 1953.

Miscellaneous Processes

Wire Supports for Electron Tubes. Fig. 6. Patent No. 2,706,366. Filed November 25, 1950. Issued April 19, 1955. Two sheets of drawings. Assigned to Bell Telephone Laboratories Inc. by Fred H. Best.

The use of higher and higher frequencies in the electronic art has imposed a need for smaller and smaller components to be utilized in devices operating at such frequencies. In particular, it is often necessary to utilize fine wire components which, despite their fineness, must nevertheless be firmly and accurately supported. To provide a helix assembly the wire conductor is first wound on a firm temporary supporting structure which may comprise a rod or tube, and the ends of the conductor are welded to the structure. The conductor is wound in a manner to provide the desired helical configuration. It is important that the supporting structure be of a material which is soluble in a solvent which does not affect the conductor material. In practice, it is convenient to use a supporting structure made of Kovar. Silver copper, gold, tungsten, platinum, and molybdenum are among the typical materials which can be used for the wire conductor. Then masking details are placed against the helix, extending along the supporting structure, and fastened in place there. Fig. 6 includes the temporary supporting structure 11, the helix 12, and the masking details 15. Thereafter, this assembly is then enclosed in an envelope 14 which just clears the masking details. Envelopes of hard glass are most convenient for this application, particularly when used in conjunction with Kovar supporting and masking structures becuse of the similarity therewith of temperature expansivity coefficients.

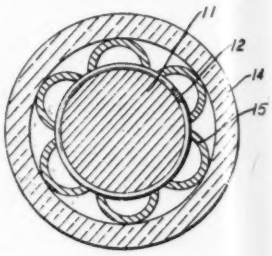

Fig. 6

The patent contains three claims and sixteen references were cited.

Hypodermic Syringes. Patent No. 2,736,992. Filed April 16, 1951. Issued March 6, 1956. One page drawings; none reproduced. Assigned to Becton Dickinson and Co. by J. V. Magash and Chas. Messineo.

This invention relates to a structurally and functionally improved hypodermic syringe assembly. The improved syringe is readily sterilized and no objectionable leakage or "back-flows" will occur and a physician or other user is able to easily observe a solution within the barrel. The glass hypodermic syringe barrel is formed by providing a glass barrel preform presenting a bore with a smooth integral surface. The barrel is then shrunk under the action of heat and pressure. Incident to the shrinkage discrete particles are brought to extend beyond the bore surface and are casually spaced with respect to each other with major bore areas intervening. The particles are ultimately removed from the bore surface with the line of severance being not beyond such surface to prevent a transparent finished syringe barrel. The clear portion is interrupted only by microscopic areas defining points at which particles were severed.

There were nine claims and 10 references cited in this patent.

(*Continued on page* 356)

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Al_2O_3	16.35%
Fe_2O_3	0.86%
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MgO	0.09%
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Russian Translations . . .
(*Continued from page* 334)

tracts k moles Al_2O_3 and m moles SiO_2 for every mole Na_2O, plain dissolution takes place. This occurs when log n for Na_2O is equal to log (n/k) for Al_2O_3 and by log (n/m) for SiO_2.

Fig. 3 shows the amounts leached out by water in 6 hours at 40°C. Curves 1 are for sodium silicates, and the lower line under the abscissa indicates the excess of SiO_2 over $Na_2Si_2O_5$; thus, the zero mark corresponds to $Na_2Si_2O_5$, abscissa 1.0 to $Na_2Si_3O_7$, and so on. The upper curve 1 is for Na_2O, and the lower is for SiO_2. It is seen that more Na_2O than SiO_2 is leached out at any ratio Na_2O:SiO_2 between 1:2 and 1:4.

Curves 2 of Fig. 3 are valid for sodium alumosilicates $Na_2O.kAl_2O_3.2SiO_2$ (hence, lg n_2 written in the graph). The highest curve shows the loss of Na_2O, the middle curve, the loss of SiO_2, and the lowest curve represents the loss of Al_2O_3. The upper line under the abscissa is equal to k in the above formula. It is seen that addition of Al_2O_3 improves chemical endurance of $Na_2Si_2O_5$ in water more than addition of SiO_2, is one molecule Al_2O_3 is counted as equivalent to two molecules of SiO_2.

The chemical endurance in dilute acids is affected by Al_2O_3 in a different manner. This is illustrated in Fig. 4. All its curves are for alumosilicates $Na_2O.kAl_2O_3$-$2SiO_2$, and k is shown along the abscissa. The upper solid curve represents the loss of Na_2O during an attack by N hydrochloric acid for 8 hours at 40°C. The lower

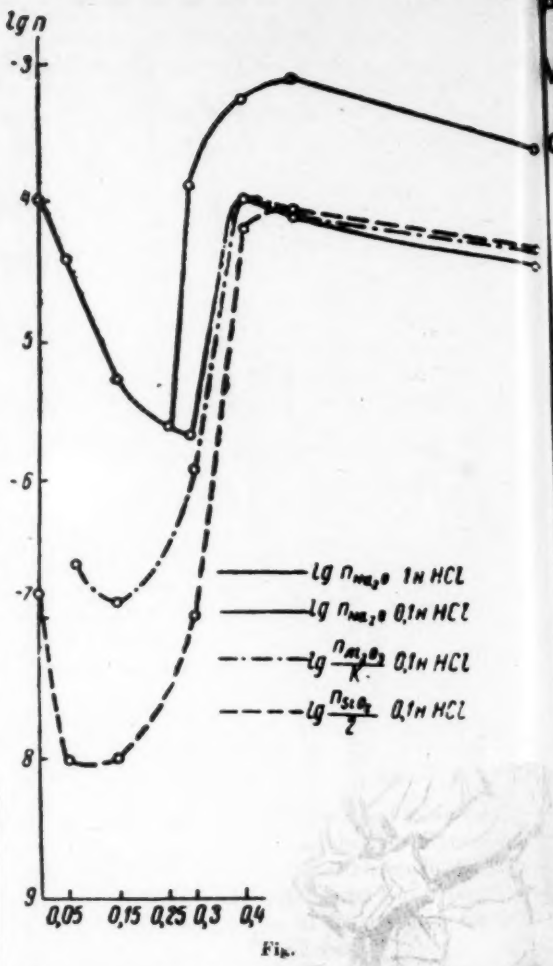

Fig.

solid curve is for an analogous attack by hydrochloric acid. The dash-and-dot curve shows the leaching out of Al_2O_3, and the dashes show the leaching out of SiO_2, both by 0.1 N HCl.

It is clear from Fig. 4 that small additions of Al_2O_3 (up to k=0.3) greatly improve the endurance in dilute acids while large additions are deleterious. Between k=0.5 and k=1, the glass dissolves as such.

No explanation can be advanced yet for the maximum of the rate of corrosion near the composition $Na_2O.0.5Al_2O_3.2SiO_2$. This maximum cannot be accounted for by a change in the coordination number of aluminum, because the refractive index of the alumosilicates $Na_2O.kAl_2O_32SiO_2$ linearly increases with the mole percentage of Al_2O_3 without any irregularity at the above-mentioned composition.

The alumosilicates studied were corroded by sulfuric acid more than by hydrochloric or nitric acid of an equal concentration.

• Carl P. Mann, manager, drier, oven and lehr division, Selas Corporation of America, Dresher, Pa., announces the appointment of Clifton W. Corbett as assistant to the manager, drier, oven and lehr division. Mr. Corbett will serve in a sales engineering capacity and will direct his activities to increasing the sales of heat processing equipment.

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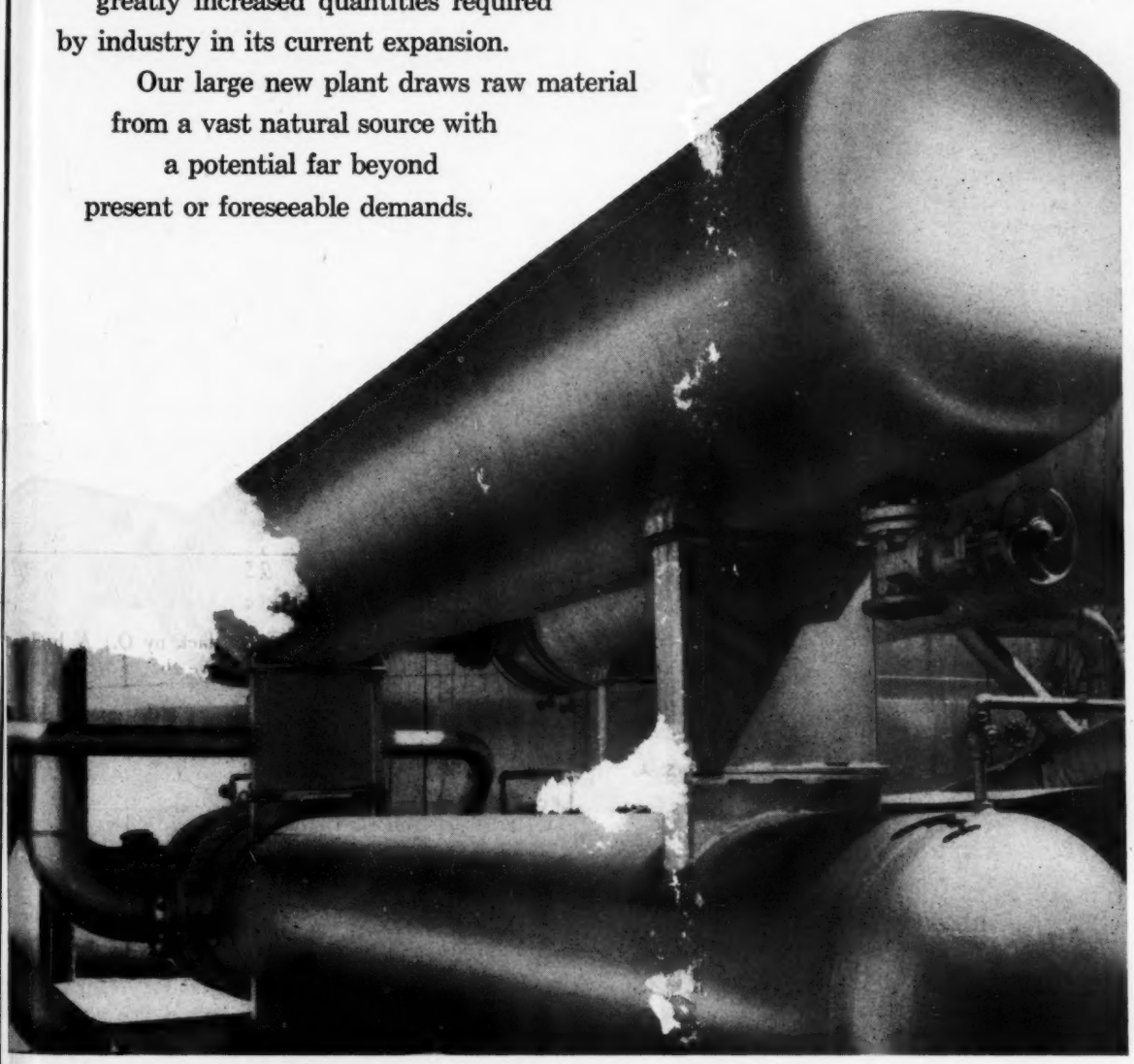

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